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WILLIAM HAND BROWNE, JR. . . . . TECHNICAL EDITOR
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ELECTRIFICATION OF RAILWAY TERMINALS.

It seems to be generally admitted that one of the fields in which electrical operation is going to be rapidly introduced in the near future is in the operation of congested railway terminals and suburban sections in the vicinity of large cities. This will be brought about for various reasons, and will improve the service in every respect. Several systems of electrification are available for this purpose, though there are but two at present considered in this country. These are the direct-current system, usually operating by means of a third rail, and the single-phase, alternating-current system, which may use a third rail on sections where a low voltage must be employed, but resorts to an overhead wire where higher potentials are allowable. Each of these systems has its advantages, but it seems impossible at the present time to say which of the two will be found to be the more suitable for the work, all conditions being considered.

This question is in a fair way to be given a thorough study, for the New York, New Haven & Hartford Railroad has completed arrangements by means of which it will be able to obtain power from the New York Central & Hudson River Railroad for operating its trains while they are running on the tracks of the latter road within New York city. The New York Central, it will be remembered, started to operate its electrical trains last fall, and has been gradually increasing this service, until now all of its terminal trains are moved in this way. The New Haven road has secured nearly all its equipment of single-phase, alternating-current locomotives, and thus it will be able to banish the steam locomotive from the New York section of its system. Here there will be, then, two large roads operating not only in the same neighborhood, but for some distance over the same tracks, one using one type of equipment, and the other another. The conditions for a thorough testing-out of these two systems could not be better, and the fact that they are being tried by independent companies is a guarantee that there will be no favoritism shown, as each road is upon its mettle to demonstrate that the system which it selected is the better.

The strikingly different features of these two systems are the following: The New York Central uses a comparatively low-potential distributing system requiring a large conductor, and has therefore adopted the third rail; and it has selected the direct-current motor and a special type of locomotive for hauling its heavy through trains. The suburban trains are operated on the multiple-unit system. The New Haven road decided upon its equipment later than the other. It selected the alter-

nating-current system, distributing its power while on its own lines at a fairly high potential, and has adopted the single-phase motor. All of its trains, both suburban and through trains, are to be hauled by locomotives. There are therefore three factors entering into the problem: the voltage, the type of motor, and the use of motor-cars or of locomotives, and it seems probable that in spite of the very favorable conditions under which a comparison of the systems will be made, no final decision will be reached thereby, unless, of course, one system proves hopelessly inadequate, an event no one expects. Unfortunately, therefore, these magnificent tests in the vicinity of New York will not decide the problems arising at other places, though they may demonstrate thoroughly the reliability of each system, and still further experience will be necessary before any unbiased engineer can say decisively that the one system is decidedly better than the other.

ELECTRICAL EFFECTS ON LIVING ORGANISMS.

In a most interesting study contributed to the *Memoirs of the American Academy of Arts and Sciences*, Dr. John Trowbridge describes the experimental investigations which he has been enabled to make by means of a high-tension storage battery which made available electrical discharges of 40,000 volts and more, the intensity of the current being about eight amperes. With such powerful discharges, striking phenomena were observed, and some little light seems to be thrown upon lightning discharges, since the battery enabled Dr. Trowbridge to reproduce on a miniature scale the effects which Nature, in her uncircumscribed laboratory, produces in magnificent proportions. Certain important observations are also made in the field of spectrum analysis, it being shown that a spark discharge between metallic terminals may not represent the true spectrum of the metal. Thus, a serious question is raised for the chemists.

However, there are other features in Dr. Trowbridge's paper which appeal not merely to the physicist and the chemist. By means of this battery he was able to simulate the effects of fatigue of living organisms. Of course, as is well known, any voltaic battery, when overtaxed, shows fatigue, or what is called specifically, though rather indefinitely, polarization. But it is not in this way that the phenomenon of fatigue was indicated. The effect was shown in this way: when charging condensers by means of the battery, through a high resistance, on account of the quantity required and the limited rate of flow, an appreciable time was required to bring the condensers up to the potential of the battery. When this point was reached, however, the batteries discharged across a gap, and recharging at once recommenced. After a similar lapse of time the batteries again discharged, and the phenomenon was repeated at regular intervals as long as the arrangement was maintained. An interesting means was thus obtained for marking definite time intervals, though it is probable that the accuracy of the division is not very great, as too many varying factors, such as the temperature of the resistance, and the diffusion of the acid in the battery, enter into the process.

Commenting upon this effect, Dr. Trowbridge calls attention to the time element which enters into the phenomenon as though the battery were fatigued and time were required for it to recover, although, as the description of the experiment shows, this effect did not necessarily enter into the experiment. This feature of the experiment and the somewhat complicated means which enable high tensions to be obtained lead Dr. Trowbridge to comment upon certain physiological explanations of noteworthy electrical effects produced by certain animals. These severe shocks which are produced in this way can not themselves, according to physical ideas, be produced in a way similar to that by which lightning is caused; in other words, the organisms can not be likened to a huge condenser charged to a high potential. The explanation usually given of this effect is that the organ consists of a great number of small elements, each of which produces its own minute effect, all of which effects the animal can at will add together. This explanation, also, is not acceptable to the physicist, for it has not been shown how the intricate mechanism which connects all of these cells in series acts. Before this theory of animal electricity can be accepted, it must show how these units are thrown into series.

Dr. Trowbridge also calls attention to the frequent use of the idea of an electric current to explain nerve action, and the descriptions of experiments made to detect the effect of one nerve upon a neighboring one. This is done in spite of the fact that the rate of travel of nerve action is only about 100 feet a second, which is entirely too slow to produce an effect similar to an electrical impulse. He points out, however, that there is one analogy between the action of a nerve and that of a battery. This is the polarization or fatiguing effect due to continued use. If allowed to rest, diffusion of the exciting fluids takes place, which restores the cell, though necessarily in a somewhat weakened condition.

There is always danger, in studying such complicated processes as take place in a living body, of confusing effects and causes, and it may not infrequently happen that the very device employed to study a certain action itself upsets the original conditions. Suppose, for instance, some one who knew little of electrolytic action should take it into his head that the heat produced by the action of an acid on a metal was due to electric currents set up in the combination. He would argue that if he introduced some inactive material into the cell, this would not change the conditions, and he might, by means of it, be able to detect an electric current. Suppose he introduced a platinum wire into the acid and brought the other end in contact with the metal being dissolved. He would not have much difficulty in showing that a current was passing through his platinum wire, and would thus consider his theory proved; yet we know that the introduction of the inert metal makes it possible for a current to flow where there was no current before. Thus, in studying physiological problems, particularly if the electrical effects are sought, the greatest care should be taken to prevent the research apparatus from in any way influencing the result. The current, even if it be detected, may not be the cause of the action,

but may only be an effect of the cause, or may be an effect introduced by the investigating instrument. We are too apt to forget that energy is easily transformed, and when any action liberates it, it will appear in that form which offers the easiest outlet for it. A chemical action may only give rise to heat, but under more favorable conditions it will give rise to the higher form of energy represented by an electric current; and usually when this happens, the rate of liberation of the energy is increased. So, in physiological actions, energy, it would seem, must necessarily be set free, due possible to some chemical action, and this may appear as heat or as electric current, or even in some other form, depending upon the conditions; but the form which this takes may have absolutely nothing to do with the original cause.

FORCES IN THE INTERIOR OF AN ELECTRIC CONDUCTOR.

Some time ago reference was made to the interesting phenomenon observed when a heavy current of electricity was passed through a liquid conductor. The latter tends to contract and may even be entirely divided by the current. In the *Physical Review* for June, Dr. Edwin F. Northrup deals in some detail with the physical forces set up by the current which cause this contraction to take place. He recalls an interesting experiment suggested by Maxwell, in which two permanent magnets are suspended so that they are free to rotate in a plane normal to a conductor carrying current. If similar poles of the magnets are placed adjacent to the conductor, the opposite poles being directed away, a couple will be set up by each pair of poles, each acting to revolve the pair of magnets in the opposite direction around the conductor. Due, however, to the fact that the poles of each magnet are of similar strength, and that the field of force varies inversely with the distance of the pole from the conductor, the resulting couples exactly balance, and no motion takes place. Passing, however, into the conductor, a different state of affairs is found. There can be no magnetic force within a closed conductor due to current passing through it; if, therefore, the conductor be considered as a series of concentric cylinders, the current in each of these cylinders will set up a magnetic field around it, but will give rise to no field within it. There will hence be a magnetic field at the edges of the conductor, due to all the elementary cylinders, and from here the field will decrease in strength to the centre of the conductor, where it will be zero. In other words, the strength of the magnetic field varies directly as the distance from the centre of the conductor. If, therefore, Maxwell's experiments be performed within a conductor, rotation should take place; and by using an electrolytic conductor consisting of a column of copper sulphate, it was found that the action did occur.

Another interesting experiment is based upon Ampere's idea of a current flowing in a conductor. He considered that a conductor might be looked upon as a bundle of conductors, each of which is carrying its own current. Now, if a conductor carrying an electric current be placed within the magnetic field, a force will be set up, tending to move it in a definite direction. Since each of these elementary conductors lies in the magnetic field produced by all those nearer to the axis of the conductor than it, a force should be set up upon it, and this should be in the direction tending to move the element toward the centre of the conductor. In other words, the magnetic force due to the current in the conductor tends to draw the elementary currents together, to contract them, as was observed; and if they were free to move they would all concentrate in the axis of the conductor. This effect is very prettily shown by placing within the liquid conducting cylinder of copper sulphate a loose wire, which, due to its lower resistance, would carry a somewhat heavier current than the neighboring liquid filaments, and which would therefore be acted upon more strongly. It was found that this wire did move until it took a position as nearly as possible along the axis of the cylinder.

It is interesting here to note the difference between this effect and that due to an alternating current. In the latter case the current tends to flow along the surface of the conductor, thus giving rise to what is known as the skin effect. The explanation given above of the tendency of the elementary conductors to concentrate at the centre is independent of the direction of the flow of current. It therefore exists whether the current be direct or alternating. With the alternating current, however, there is a new effect due to the varying character of the current. The magnetic field set up within the conductor by this current is itself varied, and this gives rise to an opposing electromotive force. If the current be concentrated along the centre of the conductor, this effect within the conductor will be a maximum; but if the current be concentrated on the surface there will be no interior magnetic field, and the effect within the conductor itself will disappear. The ampere effect, however, is present, so that the current takes up that distribution in the conductor which the opposing forces permit; in other words, it selects the path of least resistance. When the conductor itself is not free to move the distribution of the current in it is but slightly affected, as is shown by the Hall effect. Hence the inductive effect greatly predominates. It would be interesting, however, to see if the Hall effect is measurable within a solid conductor.

It may be noted, further, that this effect of the contraction of a fluid conductor might be explained by the new theory of metallic conduction. This attributes the conduction of electricity to the motion of electrons, although these are in some way or other mixed up with the molecules of the conductor. A charged body moving in a magnetic field would tend to be deflected. The forces due to the current tend to deflect the electrons toward the centre of the conductor and to concentrate the current there. In this case, however, it is necessary to assume that the deflecting of the electrons also drives the molecules of the conducting fluid towards the centre and it is not clear how this takes place as there seems to be no movement of the molecules along the conductor with the current.

Society for the Promotion of Engineering Education.

The fifteenth annual meeting of the Society for the Promotion of Engineering Education was held at the Case School of Applied Science, Cleveland, Ohio, July 1, 2 and 3. A programme of fifty-seven papers had been arranged, the greater number of which were presented and discussed. A number of these are of interest to electrical engineers.

Frederick W. Atkinson, president of the Polytechnic Institute of Brooklyn, presented a paper entitled "Technical Education With a View to Training for Leadership." This called attention to the demand for men having a technical education, who were also able to handle men, and the author described a course of study, planned by the Polytechnic Institute of Brooklyn, to prepare men for meeting this demand. It is intended that, in addition to a good scientific and technical training, a few men shall be given a broader education. These men are to be carefully picked out, and as they advance the class is to be sorted, so as to eliminate all but the most competent. The class will be limited in number so that each head of a department comes in personal contact with all of his students.

A paper on "Central Station Design" was presented by Professor A. A. Radtke, in which the author gives his ideas of the most satisfactory way of treating the subject.

Professor J. W. Schuster read a paper entitled "Organization and Conduct of an Electrical Engineering Laboratory." The author believes that the province of the engineering school is that of laying a broad foundation for engineering practice, and the proper use of the laboratory in conjunction with theoretical analysis will do more to fix the principles thoroughly than any other agency.

In Professor Harold B. Smith's paper, entitled "The New Electrical Engineering Building of the Worcester Polytechnic Institute," this building was described. It was completed during last May, and has a floor space of 43,000 square feet, costing approximately $125,000. The present equipment of the laboratory is also described.

Professor J. W. Esterline described the new electrical engineering laboratory of Villanova College, and Professor D. C. Miller the Rockefeller Physical Laboratory of the Case School of Applied Science.

Professor C. H. Benjamin read a paper describing the use of loose-leaf notes in laboratory work, and Professor Stephen E. Slocum one entitled "Basic Principles in the Construction of a Text-Book." The author of the latter paper believes that there are three essential requisites for a text-book. To stimulate interest in a particular subject, it should utilize this interest to master fundamental principles, and it should give the student proficiency in their practical application.

Professor J. M. White, in a paper entitled "Relative Efficiency of Instruction in Engineering Subjects," described a method which had been devised to determine the relative efficiency of work accomplished by recitations, lectures, drafting-room work, shop work, laboratory work and field work. The method consists in multiplying the number of students which one instructor can handle efficiently with the number of hours which it may be reasonable to expect to devote to this work each week. Giving recitation work an efficiency designated by one, the following are the conclusions reached: lectures, 1; drawing, 1.4; designing, 2.3; shop, 1.8; laboratory, 3.5; field work, 2.

Charles F. Scott, in a paper entitled "The Technical Graduate and the Electrical Manufacturing Company," discussed the kinds of work for which technical graduates are desired, and the special qualifications necessary for success.

Professor Henry H. Norris discussed methods of studying current technical literature.

Dr. W. S. Franklin described "A Course in Physics for Engineering Students."

There were groups of papers dealing with special topics, such as the functions of the dean of colleges of engineering, methods of conducting examinations, methods of teaching the elementary sciences, apprenticeship courses, and other special elementary courses of instruction in science and engineering.

There were also several papers dealing with engineering experiment stations. Professor L. P. Breckenridge described that at the University of Illinois and Professor G. W. Bissell that at Iowa State College. Professor J. H. Holmes described the work being done by the United States Geological Survey in investigating the fuels of the United States.

The presidential address, delivered by President D. C. Jackson, was upon "The Relations of the Engineering Schools to the Secondary Industrial Schools."

The following officers were elected for the next year: Charles S. Howe, president; Clarance A. Waldo and William G. Raymond, vice-presidents; William O. Wiley, treasurer; Arthur L. Williston, secretary, Pratt Institute, Brooklyn, N. Y.

Alternating-Current Electric Locomotive Test.

A test of the single-phase alternating-current electric locomotive being built by the Westinghouse Electric and Manufacturing Company for the Pennsylvania Railroad's approaches to New York city, was made at the yard of the Westinghouse company, East Pittsburg, Pa., on July 11. This is the first time that this locomotive has been exhibited to outsiders, although the work of developing it has been going on for some years past under the scrutiny of George Gibbs, chief engineer of the Pennsylvania Railroad's electric traction division.

During the test of the locomotive a speed of seventy miles an hour was attained, although the locomotive was not designed for such excessive speed. The two approaches of the Pennsylvania tunnel under the Hudson and East rivers have grades of two per cent, and the high power of the locomotive is intended to enable it to draw heavy trains up these grades, rather than to give high speed on a level. The locomotive is rated at 4,000 horse-power, and it is said that it will develop even higher speed than that shown during the test. It ran very smoothly, with a noticeable absence of swaying and rocking even at the high speeds attained.

At one part of the track on which the test was made there is a sharp grade with but slight super-elevation. This was easily taken at a speed of sixty-three miles an hour.

One section of the test track is fitted up to comply with the requirements of the Pennsylvania tunnel. Here there is a third rail instead of the overhead trolley which is used on the rest of the track. Operation on this section of the road was as satisfactory as elsewhere.

BOOK REVIEW.

"American Street Railway Investments." New York. McGraw Publishing Company. Cloth. 453 + liv pages. 10 by 13¼ inches. Supplied by the ELECTRICAL REVIEW at $5.

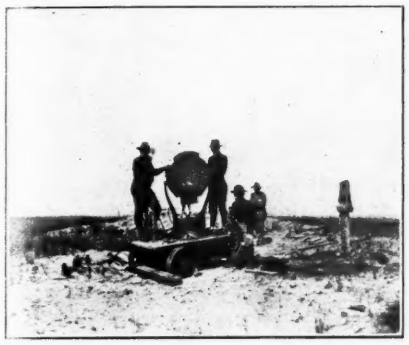
The fourteenth annual volume of "American Street Railway Investments" covers 453 pages of statistical matter, an increase of twenty-one pages over the edition of 1906. There are forty-four maps, on which the systems of forty-seven separate companies are shown. Complete data are given for the street railways of the United States, Canada, Cuba, Hayti, Hawaii, Puerto Rico, the Philippine Islands, Jamaica and Trinidad, together with a comprehensive index.

AN ARTICLE RELATING TO THE USE OF THE SEARCHLIGHT AND OTHER ELECTRICAL APPARATUS EMPLOYED IN THE PERMANENT SEACOAST DEFENCES OF THE UNITED STATES.

BY M. C. SULLIVAN.

The recent maneuvres of the permanent inner defences of the city of New York at forts Wadsworth and Hamilton in New York harbor, and Fort Schuyler on Long Island Sound, brought forcibly to mind the all-important part which the searchlight and that commonplace method of illumination in social and industrial life, the incandescent lamp, will play in case of war in the defence of the city.

Electric lighting and other applications of electricity have worked wonders in the seacoast forts of the United States. All that many of the soldiers in the coast artillery service need now is an ear to hear an order as transmitted over the telephone, an eye to see an electric button, and a finger to touch it. Electricity and the inventor do the rest. Dependence upon electricity is becoming almost an instinct among the personnel of our modern forts, and in this service electricity will perform its greatest deeds in the future.



SEARCHLIGHT PARTY, UNITED STATES COAST ARTILLERY.

To-day the science of seacoast defence has become so exact, and its instruments of execution so mechanically terrible, that individual heroism can no longer be depended upon as the important factor in determining the result of a conflict. Napoleon's statement to the effect that God is always on the side of the combatant having the most cannon is true to-day, in seacoast defence operation only when the cannon are of the most modern make, handled with the greatest degree of accuracy, and reinforced by technical skill and appliances in all branches of the fort so perfectly as to be practically flawless. In other words war on the seacoast, to-day, is not a question of men but of machinery.

Before the machinery period began in the forts, the manipulation of the guns required more muscle but less skill. More bravery was demanded, but less intelligence. There was more tugging and straining, and more danger because the men were exposed to the enemy's fire.

The skilled engineers of civil life as well as the army, who laid the hands of ingenuity on the problem of seacoast defence, have produced results which show that this department of the military art does not differ from many lines of industry, inasmuch as the process of evolution always tends to eliminate the personal factor as much as possible, substituting mechanical means for manual operation.

The extraordinary requirements of modern seacoast defence have forced military designers into the field of electricity for many of the most important elements which enter into the composition of their work. While a seacoast fort in its emplacements and the powerful guns it carries represents some of the earth's finest mechanical productions, it is in the details by which successful operation of the component parts is accomplished that we find many of the most effectual applications of the many electrical devices so familiar to social and commercial life.

The history of engineering development in the United States Coast Artillery Service is a story of constant increase in the intricacy of its machinery. From an art seacoast defence has become a science, and all experts recognize that its mastery demands a complete and technical skill undreamed of in earlier and simpler days. On every side it is showing the stamp of the machine which makes it so much harder for the layman to understand, and has made the experts who operate these engines which protect the threshold of the country just so much more necessary.

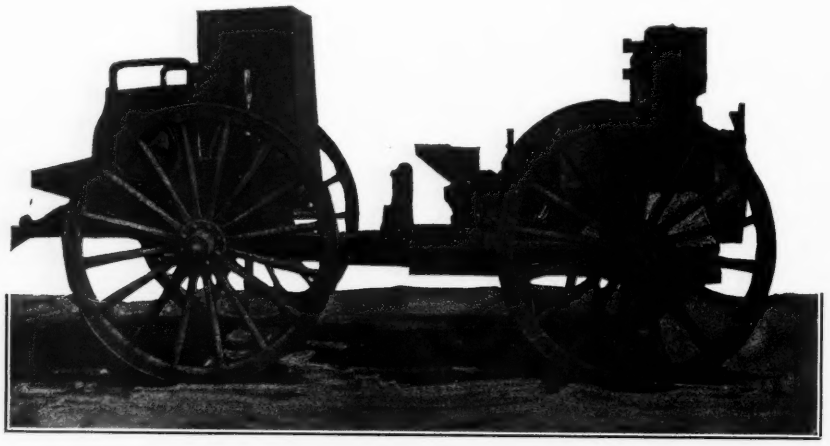
TELEPHONE SCOUTS, UNITED STATES COAST ARTILLERY.

Electrical application is scarcely more diversified in any small city than in a first-class fort, nor are finer experts required than the skilled electricians, who must also be soldiers, of the coast artillery service. It would be very difficult, if not impossible, to find in so small a space a better proof of the value of many electrical devices so familiar to industrial life than from their inspection as they appear in a modern fort. The progress of fortification engineering is nothing short of marvelous. Forts that were in commission not very much longer than ten years ago, now stand only as finger-posts indicating the trend of developments. Much of this development has been wrought by the aid of electricity. The guns and emplacements stand out in bold contrast to those of fifteen years ago, but it is only when the means of operation are investigated that we find the great developments which have made seacoast defence a contest of the power and accuracy of machines, rather than a physical affair dependent upon the skill and nerve of men. The man behind the gun has by popular acclaim been credited with being the principal factor in attack and defence. It is safe, however, to state that his efforts at night will be in vain if the searchlight is not able to locate the enemy. It will therefore be readily apparent that the connecting link which serves to unite the

UNITED STATES COAST ARTILLERY RUNNING ELECTRIC LIGHT AND TELEPHONE LINES.

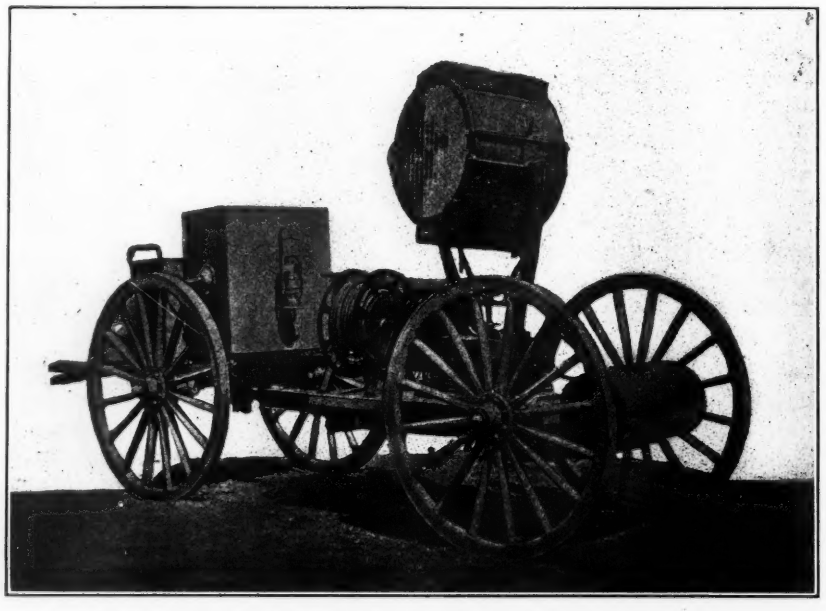
whole physical and mechanical structure is the electrical system.

Electric light is used in units ranging from the sixty-inch diameter searchlight requiring twelve kilowatts, and rated at 194,000,000 candle-power, which lights up



TRANSPORTABLE ENGINE AND DYNAMO FOR SUPPLYING CURRENT FOR SEARCHLIGHT, UNITED STATES COAST ARTILLERY.

an object two and one-half miles distant with the brightness of the full moon on a clear dark night, and enables a person located to one side of the projectile with the aid of a glass to distinguish a vessel at six miles distance, to the miniature incandescent lamp used for lighting the



TRANSPORTABLE SEARCHLIGHT, UNITED STATES COAST ARTILLERY.

cross hairs of the range-finding instruments and requiring but twenty watts.

The subject of the greatest interest at present in connection with the permanent seacoast defence of the United States is the extensive employment of electricity in connection therewith. This interest is not due simply to its present employment, but to the fact that the future development of harbor defence is largely dependent upon electrical science.

Picturesque, as were the old time seacoast forts, with their manually operated armament, they speedily yielded to the march of modern progress until to-day picturesqueness has disappeared. With the disappearance of the man behind the gun there has come a pressing need for men of higher intelligence and mental training in the seacoast defence service.

The romance and picturesqueness of standing at the guns exposed to the enemy's fire inviting the soldier to brave and valued conduct has been succeeded by the exact requirements of electricity and mechanism. What mystery remains is to be found in the massed powers of destruction, the searchlights which stab the darkness and supplement the eye of the sentry, the swinging of huge guns by the movement of tiny switches and firing them by a finger touch, the multiplication of signal systems until forts can talk to ships and each other by day or night with astonishing swiftness and accuracy and the endless succession of machines controlled directly or indirectly by electricity. In many instances the apparatus does not differ in any particular detail from the same type and class used for civil purposes, but military requirements have made it necessary to strengthen and embellish the apparatus to meet the rude shock of actual service.

The modern fort is theoretically and practically a vast fighting machine in which two forms of energy are extensively employed, explosives and electricity. The projectiles from the guns are propelled by explosives, but electricity is the reigning influence with regard to the lighting, the signaling, the adjustments of huge mechanisms such as twelve-inch guns and the actual communication established over the entire zone of operation. The searchlight has dissipated the isolation of the harbor at night and given it an entirely modern atmosphere. The scouting ships far out at sea which guard the forts against surprise are linked to land and each other by this means of intelligence, as the far-trailing searchlight stations, which would be located along the coast in times of war, would form an unbroken system.

In comparison with the rapidity with which ambition must be delivered to the guns, man is so puny that of necessity it is done by machinery. The elevators which bring up to the cannon their powder and shell, are operated easily and quickly by means of electric motors, which receive their energy from the same dynamos and storage batteries that furnish current for the searchlights, human fingers being necessary chiefly to raise and lower the levers and manipulate the switches which set the machines in motion.

New York Electrical Show.

An electrical show will be held in New York city, at Madison Square Garden, to open on September 30 next. It is announced that a very comprehensive exhibit of electrical appliances will be shown. The Garden will be laid out on a new plan, there being contemplated three avenues, designated as Edison, Westinghouse and Franklin, running east and west; and three cross streets running north and south. The lighting arrangements will be very elaborate.

A NEW TYPE OF INSULATOR FOR HIGH-TENSION TRANSMISSION LINES.[1]

BY E. M. HEWLETT.

LINK INSULATORS—SUSPENSION AND STRAIN TYPE.

The transmission of large amounts of power over long distances has reached such proportions that the voltage necessary to transmit this energy makes the problem of line insulation difficult. The so-called "pin" type of insulator has been enlarged to meet the greater demands until it has approached, if not already passed, the limits of good construction. H. W. Buck has given this matter a great deal of study in his high-potential transmission work and being dissatisfied with the mechanical features of a pin insulator, has devised a method of line construction involving the use of "suspension" and "strain" insulators. The suspension insulators support the line from above, hanging vertically beneath the cross-arm (or other point of suspension). The strain insulators are used at turns and at intervals of say, every mile, to support and "anchor" the line, also as pull-off insulators on curves and to dead-end lines.

It is intended in this paper to give some mechanical and electrical tests and describe a porcelain insulator which the writer has designed to carry out this method of supporting of high-potential transmission lines.

FIG. 1.—LINK INSULATOR FOR SUSPENSION.

Each insulator unit is a flanged or petticoated disc with an enlarged central portion having two interlinked semi-circular holes. It is called a "link insulator" because it is used to insulate the interlinked tie-wires. The holes in the insulator are so arranged that the tie-wires which pass through them exert a compression strain on the porcelain (Fig. 4). Should the insulator break, the loops of the tie-wires will still be intermeshed, and as the discs are used in series, with a factor of safety, the remaining discs will prevent a ground being formed until the break can be repaired. The link insulator for suspension (shown in Fig. 1) is a petticoated disc, while the strain insulator (Fig. 2) is a disc with a grooved flange.

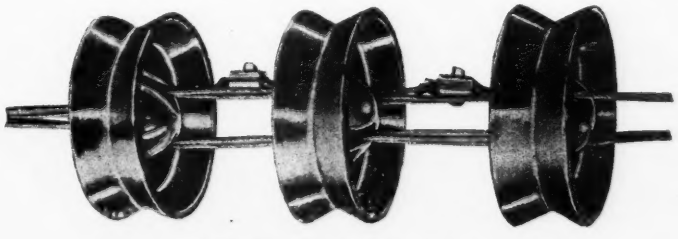


FIG. 2.—STRAIN INSULATOR.

The mechanical and electrical features of the two forms of insulator are essentially the same. The petticoats and flanges are so arranged that one side of the insulator is always protected from rain.

A diameter of ten inches for both types of insulators has been found by experiment to be most convenient and such insulators are suitable for a working voltage of 25,000 volts per disc. For higher potentials the discs are placed in series; for instance four ten-inch discs would be suitable for a 100,000-volt line. As the separate discs are over wet at approximately 65,000 volts, the rated voltage of 25,000 volts is within safe limits. The ten-inch discs were tested and did not fail with a load of three tons.

The insulators described above being made of one piece of porcelain, no cemented fittings or sections are necessary. They are not affected by extreme heat or cold, having stood the test of a severe winter. Tests prove that insulators with sheltered surfaces stand a much higher rain test than a much larger insulator which has no dry surface, as for example, a flat disc without the flange or petticoat.

FIG. 3.—POSSIBLE METHOD OF LINE SUPPORT.

FIG. 4.—ILLUSTRATING STRESS OF TIE WIRES.

Fig. 3 shows a possible method of line support using ten towers per mile, in which the line is anchored at the end of each mile and at curves, and suspended at intermediate towers. From the cut it will be noted that the conductor is looped around the strain links at the anchorage towers. The use of this type of insulator does away with torsional strain on the cross-arms, giving it a decided advantage over the pin insulator. It is obvious that the link insulator is adaptable to a great variety of conditions.

Fittings have been designed for use with these insulators to fit the conditions thus far presented, but each case should be considered as it comes up and such fittings designed as are necessary.

[1] A paper presented at the twenty-fourth annual convention of the American Institute of Electrical Engineers, Niagara Falls, N. Y., June 26, 1907.

SOME NEW METHODS IN HIGH-TENSION LINE CONSTRUCTION.[1]

BY H. W. BUCK.

The great economies in the cost of generating power which have been obtained in the large steam turbine stations and hydroelectric plants are leading to the general abandonment of small generating stations and the increase in transmission distances in order to distribute power over a large territory. In other words, 100,000 horse-power can be generated in one station and transmitted 100 miles cheaper than it can be generated and distributed from ten 10,000-horse-power stations near the centre of load. On account of this tendency toward the concentration of generating units, the overhead transmission line has assumed a position of great importance in electrical installations, and the same permanency and reliability is demanded of it as of the generating station itself. The wooden pole line of the past has been practically abandoned and steel construction has been substituted.

The long distances required for many of the modern lines, the large amounts of power to be transmitted, and the very high price of copper and aluminum—all have combined to force up the transmission voltage to the highest practicable limit. In consequence the demand for high-voltage overhead line insulators has outgrown the present standard practice, and some new systems will have to be introduced to meet the new conditions.

The method of line construction here described has been developed by the writer and E. M. Hewlett and is believed to offer a means of operating lines safely at higher potentials than is practicable with insulators of the pin and petticoat type.

Fig. 1 illustrates in a diagrammatic way the arrangements for one circuit. The tower supports shown here are those which were used merely for experimental work and need not be considered as a commercial design. Each span is dead-ended at each support as shown, through a series of insulating units which in this case are plain discs connected together with steel links. The various spans are then electrically connected by jumpers hung below the insulators. The insulators are directly attached to the cross-arms, eliminating all pins. The number of discs linked together in series depends upon the line voltage, the discs themselves being identical for all voltages.

[1] A paper presented at the twenty-fourth annual convention of the American Institute of Electrical Engineers, Niagara Falls, N. Y., June 26, 1907.

Fig. 2 illustrates a design for a 100,000-volt two-circuit line which is soon to be constructed for transmitting 50,000 horse-power 165 miles. The spans in this case will range from 500 to 1,000 feet in length. Here the line is suspended below the cross-arm on most of the towers. The lines will be dead-ended with jumper connection as shown only at angles and on tangents at about every fifth tower. This dead-ending will be for the purpose of stopping any creeping of conductors on

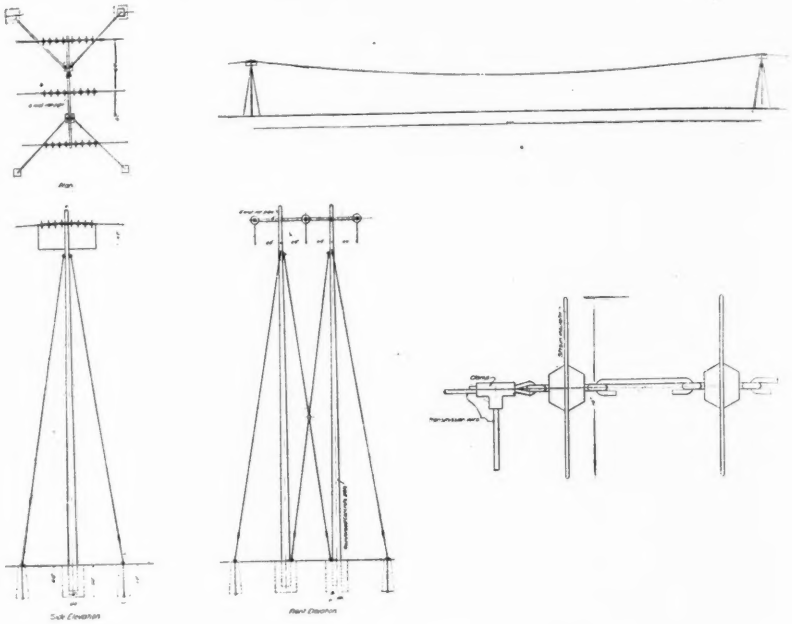


FIG. 1.—DIAGRAMMATIC ARRANGEMENT OF ONE CIRCUIT.

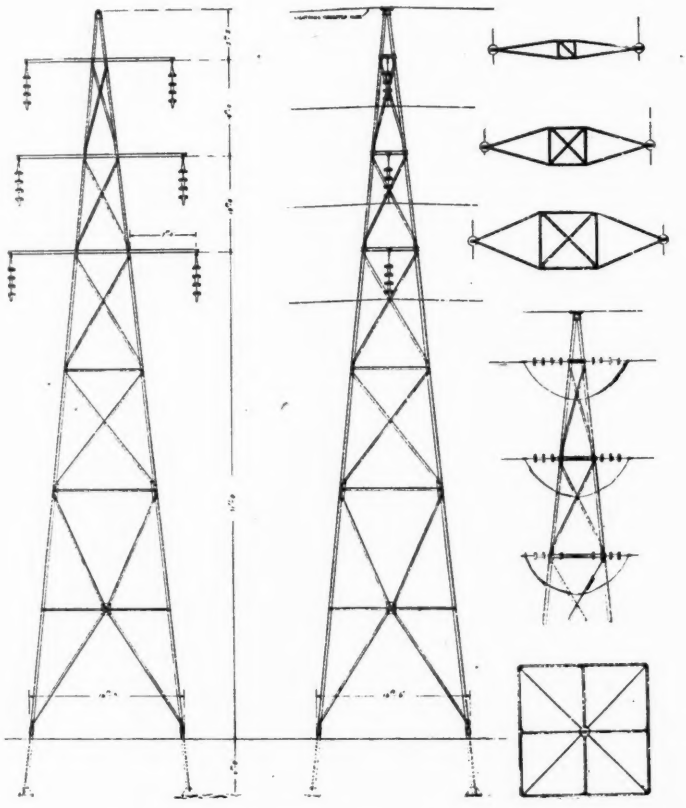


FIG. 2.—DESIGN OF 100,000-VOLT, TWO-CIRCUIT LINE.

the line as a whole, to check the transmission of longitudinal waves along the conductors due to wind, and on curves to take the side stress of the conductor due to change in direction. In this installation the lines will not be triangulated, but at

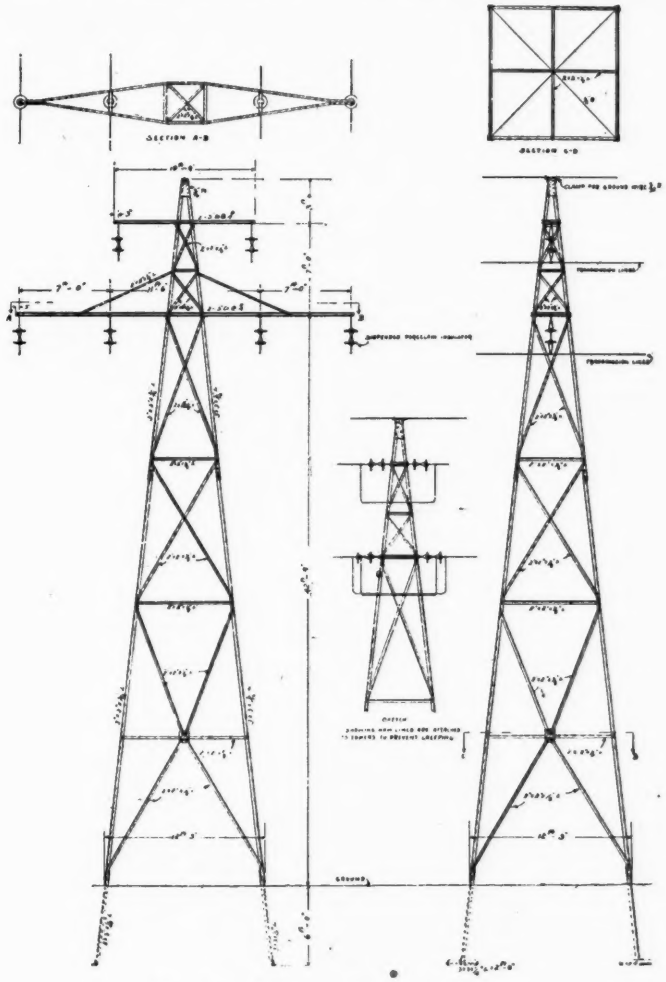


FIG. 3.—80,000-VOLT TWO-CIRCUIT LINE.

suitable intervals along the lines the conductors will be transposed so as to balance up effects of mutual static and magnetic induction. Special cross-arms will be installed at transposition towers.

Fig. 3 illustrates another design for a two-circuit line which is to be built for 80,000-volt operation. The spans in this case will range from 300 to 400 feet and the conductors will have an approximate triangular relation. The conductors will be suspended by a series of insulators from the cross-arms as in Fig. 2 with occasional rigid attachment, for the reasons given above.

Fig. 4 shows a method of assembly of the insulators for suspension under a cross-arm. Fig. 5 illustrates a method of assembly where spans are dead-ended at the cross-arm with jumper connection.

The advantages of this construction, which might be termed "series unit insulation," over the pin and petticoat type may be summarized as follows:

1. With the standard type of pin insulator now used the difficulties of construction increase very rapidly at the higher voltages. The cost of insulator for a given margin of safety increases for voltages above 60,000 nearly as the cube of the increase in voltage. Either very large petticoat diameters must be used, or very high insulators with many petticoats. In either case the manufacture of the porcelain parts is a difficult and expensive matter, and with the long pin necessary the mechanical stresses from the line on insulator, pin, and cross-arm are objectionable. With the series unit system here proposed the cost of insulator progresses only in direct proportion to the increase in voltage, the only change being in the number of units in series. There is practically no limit to the degree of insulation obtainable.

2. One of the most difficult elements of design in a transmission tower where long pins and petticoat insulators are used is to obtain a cross-arm which will resist the torsional stresses due to the leverage of the pin. With the pin entirely eliminated, the stresses are directly applied to the cross-arm; this cheapens the construction of the tower.

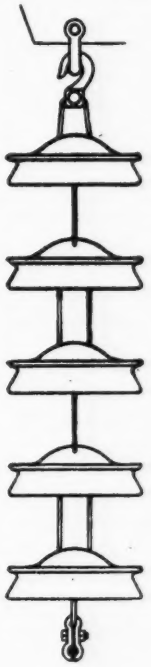


FIG. 4.—ASSEMBLY OF INSULATOR FOR SUSPENSION UNDER CROSS-ARM.

3. In the arrangements shown where the insulating units are attached on either side of the cross-arm, taking the full tension in the line with jumper connection between spans, the insulation can be increased indefinitely by adding discs in series without increasing the space occupied on the tower.

4. Where each span is dead-ended, as in (3), all faces of the insulating units are exposed to the cleansing action of the rain, so that dirt can not accumulate thereon. This arrangement also prevents the dripping water from forming electrical communication between units as occurs

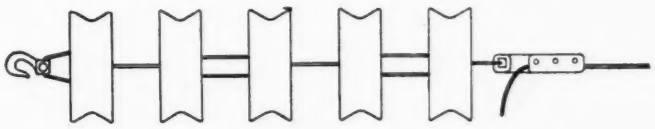


FIG. 5.—ASSEMBLY OF INSULATOR FOR DEAD-ENDING.

from one petticoat to another in the pin type of insulator.

5. A standard insulating unit can be adopted for all voltages, the only variation being in the number linked in series. This simplifies the manufacturing problem.

6. If any insulating unit becomes damaged or completely shattered the insulation of the remainder is not affected. The damaged unit can be replaced without the necessity of renewing the whole.

7. If a tower is directly struck by lightning the cross-arms will be likely to make the discharge, since they are above the lines, whereas in the pin type of insulator the line is usually the highest point.

8. In long-span installations where the conductor at each end of the span is tied fast to an insulator mounted on a pin, experience has shown that crystallization is apt to take place in the conductor at the tie, due to its rigidity at that point and the vibrations in the span. This frequently results in breakage of the conductor. The flexible connection between conductor and cross-arm afforded by the series of insulators should reduce this tendency to crystallization, and should therefore permit spans of any length to be used without further precautions against this action.

Fears may be expressed that with the conductor suspended under the cross-arm series swinging to and fro might take place. From numerous observations it is believed that no such swinging will occur. Long aerial spans under wind pressure take a permanent and steady deflection throughout the span proportional to the average wind velocity along the span, and no indications have been observed of long spans responding to so-called gusts. The towers shown in this paper are designed so that the conductor can safely be deflected by the wind about sixty degrees on either side of the neutral position.

Insulators of a great many forms have been built and tested, but the one which gives the best results electrically and mechanically is the "link type" developed by Mr. Hewlett and having the grooved or fish-tail periphery. Four of these in series is sufficient for 100,000-volt operation with a liberal factor of safety.

A very important element in this construction is of course the methods of fastening the insulating units together and attaching them to the line and cross-arms. This can be accomplished in many ways and several methods have already been worked out, but these details are beyond the scope of this paper. Further experience in practical line construction and operation under this system will demonstrate the best methods of installation and attachment.

Electrical Equipment in a Northwestern Paper Mill.

The Willamette Pulp and Paper Company, of Oregon City, Ore., has recently added to its plant a second factory which with the older mill enables the company to produce 140 tons of newspaper per day. The complete plant of the Willamette Pulp and Paper Company is one of the largest of the kind on the Pacific coast and supplies paper for the principal daily newspapers of the Northwest.

The new mill, being for the most part electrically driven, furnishes an excellent example of the advantage of this flexible method of power distribution. The Willamette river at this place has a fall of about twenty-five feet and the old mill of the company is located at the brink of the falls. The new mill is about 1,000 feet distant and is driven by induction motors supplied with current from a water-wheel-driven generator located in the old mill. By utilizing the electric system in this way, it has been possible to develop some 750 additional horse-power at the falls and at the same time locate the mill advantageously.

The electrical equipment was furnished by the General Electric Company and consists of a 600-kilowatt, three-phase, 600-volt revolving-field, alternating-current generator, direct connected to a 1,000 horse-power water-wheel built by the Platt Iron Works. The power is transmitted directly at the generator voltage.

To insure against a shut-down in the new mill, arrangements have been made with the local company for power, should any accident happen to the paper company's generating equipment.

In the new mill, both group and individual induction motor drives have been arranged. The motors are all of the squirrel-cage type and operate at 550 volts. One group consists of a twelve-inch by twelve-inch chipper, a chip separator, a saw-dust conveyer and a buckethoist, driven by a 200-horse-power induction motor. The motor is operated about eight hours per day and carries the load easily, no matter how hard the chipper is crowded. The buckethoist carries the chips into bins ready for the digester.

A second group driven by a 200-horse-power induction motor consists of three pumps and four beaters, each handling 650 pounds of pulp. This motor runs continuously twenty-four hours per day. The beater load fluctuates greatly, varying with the amount of moisture in the pulp and the amount of pressure exerted by the operation. Owing to the large starting effort required for the beaters, a friction clutch is inserted in the line shaft so that the motor can come up to speed without load and then take the load gradually by means of the clutch.

A third induction motor having a capacity of 100-horse-power drives two chest-agitators and three pumps. The paper is reduced to the proper consistency for the paper machines in a Jordon engine, which is driven by a 100-horse-power motor.

A ten-horse-power motor is bolted to the elevator. This motor runs continuously, taking full load only when the elevator is in use. The four wet machines and three Decker machines are also driven from a counter-shaft belted to a fifty-horse-power induction motor.

Steam power is used for the operation of the 152-inch Fourdrinier paper-making machine. A 650-horse-power non-condensing engine is used for this purpose, the exhaust steam being piped to the drying cylinders on which the paper is rolled before being calendered and reeled.

Two Notable Night Pictures of New York City.

On the page opposite are presented two remarkable night pictures of New York city, reprinted from a recent Edison *Bulletin*. These pictures were taken looking up and down Broadway from the Times Building, at Forty-second street and Broadway, familiarly known as Long Acre Square, and recently changed to Times Square. To any one familiar with the city, many landmarks are at once apparent, such as the Hotel Albany, the Hotel Astor, the New York Roof Garden, the tower of Madison Square Garden; and away off to the left in the illustration looking up Broadway may be seen the big Edison sign at Shadyside, N. J. In this same picture the abrupt stop which Seventh avenue makes at Fifty-ninth street, and the black spot representing Central Park, may be easily seen. It is hardly likely that a similar set of pictures could be made in any other city in the world. The shape of Manhattan Island, running almost due north and south, with the "Great White Way" in its geographical and almost geometrical centre, adds to the effectiveness of such a view.

In connection with such pictures as these, the following statistics, which have been very recently made by the New York Edison Company, will be of interest: The Edison installation on Manhattan Island alone consists of 2,603,604 incandescent lamps, 34,119 arc lamps, and 148,333 horse-power in motors. The total connected load, including all other current-using devices, amounts to 5,050,056 sixteen-candle-power equivalents.

[Reproduced by courtesy of New York Edison Company.]

"The Great White Way," New York City. Looking South from the Times Building at Broadway and Forty-Second Street.

[Reproduced by courtesy of New York Edison Company.]

"The Great White Way," New York City. Looking North from the Times Building at Broadway and Forty-Second Street.

Electrical Notes from Great Britain.

(From Our British Correspondent.)

AN APPARATUS for relay working of long submarine telegraph cables was exhibited recently by S. G. Brown before the Physical Society of London. It consists of three parts: (*a*) the actual relaying device or drum relay; (*b*) an inductive shunt with closed iron circuit for use across the receiving coil to curb the signals and straighten out the zero; and (*c*), a method of applying a local current possessing suitable time-lag to the receiving coil to correct the tendency of signals made up of two or more impulses of the same polarity to fall away to zero due to the charging-up of the receiving condenser itself. The conditions and difficulties met with in dealing with the question of the design of a relay for long cable-work were shown to differ from long-distance telegraphy on land lines. These are:

(1.) The minute currents recorded at the end of a long cable, when working at its limit of speed, necessitate an instrument of high sensitiveness.

(2.) There is the difficulty of making and breaking contact with the usual form of "butt" contact owing to insufficient pressure to break through surface oxidation, or if contact be satisfactorily made, the want of power to break away again due to coherence of the contact surfaces.

(3.) The variation from the neutral position of a relay-tongue fixed to the coil of a receiving instrument due to the unequal charging-up of the cable and receiving condensers necessitates some method of straightening out the zero.

Burnley owns approximately eleven miles of electric trolley line which is operated municipally. In his sixth annual report, Henry Mozley, the manager of the system, mentions that for the first time the annual net receipts have been sufficient to provide the sum necessary to set aside for renewals and depreciation. Taking previous years into account there is a deficiency of $21,000, and this it is hoped to make up during 1907. Mr. Mozley states that all the axles of the last lot of double-deck cars have broken—seventeen during the past year, and now the "American 1901" axles are breaking. He says that the axles although made of the usual quality, are not strong enough to stand the shocks at points and crossings and a special steel is now being used giving much greater breaking strains. It appears that the English and American axles have broken after the following mileages:

English axles, from 15,244 to 95,419; "American 1901," 89,077 to 138,048.

The English axles all broke in the wheel-seat, gear-wheel side; the American in the wheel-seat at each end or through the gear-wheel keyway.

Since March last corrugation of rails has been rubbed out with carborundum blocks applied with an electric locomotive.

Dr. J. A. Fleming, on June 14, read a paper before the Physical Society on "The Poulsen Arc as a Means of Producing Oscillations," illustrated with experiments. Before the same meeting W. L. Upson made observations on the electric arc, and Rollo Appleyard gave an exhibition of a direct-reading conductivity bridge for rods. At the previous gathering A. Campbell dealt with and aroused an interesting discussion on "The Measurement of Mutual Inductance by the Aid of a Vibration Galvanometer." He exhibited a vibration galvanometer having a moving coil controlled by an adjustable bifilar suspension; by adjusting the tension of this the tuning is very easily effected. W. Wilson and W. Makower presented a note on the rate of decay of the active deposit from radium.

The proceedings in connection with the engineering conference arranged by the Institution of Civil Engineers, commenced in London on June 18, with the "James Forrest" lecture delivered by Francis Elgar, L.L.D., F.R.S., on "Unsolved Problems in the Design and Propulsion of Ships." On the following morning, after the president's inaugural address by Sir Alexander Kennedy, work was carried on in a number of different sections, No. VII, relating to "Applications of Electricity," being the principal one calling for reference here, though in some of the other departments as well electrical engineering matters came under attention.

C. P. Sparks briefly introduced the subject, "Modern Applications of Electricity to Mines." The principal economies following electrical use were mentioned and factors affecting the cost of power. At the Powell-Duffryn collieries, which have low-speed, steam-driven generators of 3,000 kilowatts aggregate (largest unit 1,500 kilowatts), 2,900 horse-power, being employed for haulage, the total cost per unit was 0.35 pence, and the average load-factor thirty-six per cent; 4,800,000 units were generated in twelve months. The author's notes, like those of the other papers read at this conference, were prepared for the purpose of promoting discussion. They briefly covered a number of points in electric mining applications, and were read before a joint meeting of the electrical and mining sections. The same method was adopted in discussing Bertram Blount's notes on "Electrometallurgy." Blount said that there was more solid progress being made in electrometallurgy now, than at any previous time. The subject has now been studied like any other branch of chemical engineering and its principles are well understood, with the result that processes which may be of considerable laboratory interest, but are plainly unworkable commercially, are put aside and the energy and money formerly wasted on these are directed to those which can be made an industrial success. The prosperous condition of the aluminum industry and experimental work that is proceeding for cheapening the cost of manufacture received notice, but the author said that the largest of all electrometallurgical industries will be the manufacture of steel. He said "will be" because suitable methods are only now being developed. For years inventors tried to smelt iron instead of manufacturing steel from iron already smelted in the blast furnace. That caused much delay in arriving at the present status. The Héroult and Kjellin electric furnaces were named as two of the most distinctive and promising. It was stated that probably in the first instance the electrical method would have its greatest measure of success in preparing steels of such high grade that any extra cost would be quite outweighed by the certainty that the metal would absorb no impurity in the course of manufacture. As methods cheapened, however, it might well be said that every grade of steel now prepared in open-hearth furnaces would be prepared in corresponding furnaces electrically heated. The power necessary should be obtainable from blast-furnace gases.

"Electrical Transmission Gears on Motor Vehicles," was the subject opened by A. A. Campbell Swinton. Considering

the "somewhat barbarous" method of gear-changing at present in vogue on most petrol-driven motor-vehicles, it was not surprising that attention had been turned to electrical arrangements for arriving at what was required, especially for heavy vehicles. The chief requirements were summarized and the important considerations to be taken into account when comparing electrical and mechanical methods were stated. Short descriptions were also given of several arrangements of electrical transmission that had been adopted. Campbell Swinton said the chief scope for such transmission seemed to be on heavy vehicles, such as motor omnibuses, lorries and the like, and especially large motor coaches on rails. There was still much room for development and improvement in the electrical system.

"Up-keep Charges on Large Electric Generating Sets," by H. R. J. Burstall and J. S. Highfield, was a note put forward in the hope of eliciting as much information as possible as to the differences which may exist in the charges necessary to cover the repairs and maintenance of large generating units.

"The Application of Electricity in the Working of Railway Points and Signals," by Luis de Moraes Gomes Ferreira, said that electricity had not been so prominently employed as it deserved for these purposes in England. The hesitancy in adopting it had been due to comparatively high first cost, or to doubt as to the reliability and life of motors, switches, etc., when subjected to the admittedly unfavorable conditions obtaining on the permanent way, such as wet, dirt and vibration. The principal conditions considered essential in modern signaling were enumerated. Those conditions are not all fulfilled in the usual manual and in many of the power systems, but they could be met in an electric system. In regard to cost the maintenance of an electric system should not be greater than that of the manual system, as the money spent in cleaning, oiling, painting, and renewing rods and wires is saved and will cover the cost of electricity used if an economical system be adopted.

In a paper on "Dock Equipment," read in the harbors, docks, and canal section, W. W. Squire shortly discussed the relative advantages of electric and hydraulic appliances in connection with a great variety of operations. In regard to cost he said it was difficult to institute a comparison between the cost of an electric generating station capable of supplying light as well as power, with that of a hydraulic pumping station which would supply power only, but for two stations containing plant of equal horse-power the advantage of first cost was in favor of the electric machinery. The increasing use of electric appliances in docks will show still further development with added experience.

In the mining section, G. A. Denny dealt with problems of the Witwatersrand goldfields, and said regarding winding, that this problem comprised both the hoisting of ore and the raising and lowering of men into the mines. He personally had a leaning toward the electrical double-stage system. Hoisting along inclines from the bottom of deep-level shafts would probably be electrical. The problem was the choice of system, whether rheostatic or flywheel control. Denny favors the first for short and the second for long hauls. E. M. Hann, in his notes on "Arrangement and Design of Colliery Surface Works," had, of course, to touch a good deal upon electrical application. In the shipbuilding section, H. A. Ruck-Keene, in "The Welding of Structural Materials in Place," devoted attention largely to electric welding systems; and in the waterworks department Messrs. Hawksley and Davey discussed the comparative cost of pumping by steam, internal combustion engines, and electricity, based upon actual working.

In addition to the discussions on these and many matters allied to electrical engineering, there were a large number of visits to the larger and more interesting among the power stations, telephone exchanges, and other electrical undertakings in the vicinity of London. The conference closed on Friday, June 21.

During the past month the manager's section of the Municipal Tramways Association have held a two-days' meeting at Blackpool. The discussions, which took place in private, were on the following subjects: single truck and bogie cars; current consumption (meters); corrugation of rails; pay and other allowances to motormen and conductors; air-brakes; accidents and transfer tickets.

The annual conversazione of the Institution of Electric Engineers, always one of the most enjoyable electrical events of the year, took place at the Natural History Museum, South Kensington, when the 1,400 to 1,500 guests were received by President Glazebrook and his wife, and Lord Kelvin (president-elect) and Lady Kelvin. The Institution students' section has arranged for a tour among the electrical works and system of Switzerland, commencing on July 5 and concluding July 13.

At the time of writing the London County Council Electric Power Supply bill is being most exhaustively analyzed by the Select Parliamentary Committee that has been appointed to examine its latest proposals. That the powers if, and when obtained, will be leased to private enterprise with full protective clauses and conditions inserted in the interests of taxpayers and consumers, is certain. The leasing or transfer conditions are at this moment under consideration.

ALBERT H. BRIDGE.

June 22, 1907.

New York Central and New Haven Agree Upon Power Arrangements.

The New York Central & Hudson River Railroad Company and the New York, New Haven & Hartford Railroad Company have arrived at an agreement as to the terms upon which the Central will supply electric power to the New Haven for the running of the latter's trains to Woodlawn, from which point they will proceed under the road's own alternating-current system. An act of the New York State Legislature requires that all trains running out of the Grand Central Station be operated by electricity by July 1, 1908. The New York Central has found it possible to comply with the requirements the first of July—a year earlier than was contemplated by the Legislature. The New Haven company, it is understood, is ready to begin electric propulsion, and thirty-three of the thirty-five electric locomotives ordered from the Westinghouse company have been received. The power-house for the electrical zone of the New Haven north to Woodlawn has been built at Cos Cob, and the transmission circuits and trolley lines are in working order. It is stated that the electric locomotives furnished by the Westinghouse company have been thoroughly tested, and have been found to meet all requirements.

ELECTRICAL MINING NOTES.

BY SYDNEY F. WALKER.

THE MEETING OF THE MINING INSTITUTE.

There was not much of interest to electrical engineers at the recent meeting of the Mining Institute. For the first time for some years, there was no electrical paper, but three of the papers contained matter which was of considerable interest, though indirectly, to those who are engaged in applying electricity to mining work. The Rev. G. M. Capell, whose fans are in use for the ventilation of mines pretty well all over the world, had a short interesting paper on "The Use of Duplicate Fans." I think I have mentioned in these Notes, the difficulty that arises in some cases where mine fans are driven by three-phase motors, and where the speed of the fan is required to be lowered at certain times. It is a practice with English colliery managers to lower the speed of the fan at the week ends, and also to vary it with the barometric pressure. The ordinary three-phase motor, it will be remembered, does not lend itself conveniently to variation of speed, without the employment of wasteful resistances, except by altering the number of poles in the stator. This latter arrangement should meet the difficulty, but it apparently does not meet with much favor, and meanwhile Mr. Capell has worked the matter out in his own way. He provides two fans, identical in every respect, and places them side by side, at the top of the up-cast pit, and divides the fan drift leading to the fan chamber into two by a vertical partition. The two fans produce two distinct currents of air in the mine, and Mr. Capell arranges merely to stop one fan at the week end, allowing the other fan to furnish the quantity of air that is required. He states in his paper that after the two fans have been running together, say furnishing 200,000 cubic feet of air per minute, when one fan is stopped the other will furnish more than its 100,000, more like 125,000 cubic feet, or thereabouts, without altering its speed, and this, in his opinion, is a better solution of the problem than the employment of one fan, and altering the speed of the motor by reducing the number of poles. There are several important points worth considering, from the electrical engineers' point of view, in the arrangement. I have before pointed out in these Notes that the arrangement of the ventilation of a coal mine is exactly similar to the arrangement of a system of conductors for supplying electricity for light or power. The shafts and the main roads occupy the same position to the air current, as the main supply conductor occupies in electrical distribution, the branch roads supplying working faces, and connecting the main roads occupying the same position as the branch conductors supplying lamps or motors, and connecting the feeders. Further, the arrangement proposed by Mr. Capell of two fans running side by side will be recognized as very similar to the arrangement of two generators running in parallel. Mr. Capell also sometimes arranges two fans in series, the inlet of one fan being connected to the outlet of the other fan, and the outlet of one fan being open to the atmosphere, the inlet of the other fan being connected to the mine. This will be recognized as similar in arrangement to two generators connected in series. But apparently there is a distinct difference between the working of two fans in parallel, and two generators in parallel, in certain respects, though in some respects the working is similar. Thus, Mr. Capell has found it necessary to provide doors leading to the inlet of each of the two fans, which close automatically if the pressure generated by one fan exceeds that of the other, for the reason that the fan with a lower pressure is unable then to deliver its air current, or at best delivers it very wastefully. When the two fans, however, are delivering their air currents with exactly the same pressure, the two pressures are added together, and for the reason that the pressure demanded, in order that any velocity of air current may be obtined, varies directly as the square of the velocity, or, to put it the other way, the velocity of the air current varies as the square root of the pressure, or water gauge. It will be remembered that air pressures are measured in inches of water gauge, the inch on a water gauge being equal to 0.578 ounces per square inch. It will be seen that this is quite different from the working of two generators in parallel, where the pressure remains the same, whether one or a dozen generators are working. When the fans are connected in series, the pressures are also added. The question as to which is most advantageous, the parallel system or the series system, is rather one for practical experience, but it may be mentioned that where fans have been employed underground, to assist the air current, in the same manner as we employ boosters, the result has not been so economical as has been expected. I think that a good deal remains to be learned about the operation of fans when working together, just as there was a good deal to be learned about generators working together in days gone by. The fan produces a continuous current of air by a succession of impulses, and it will easily be understood that if two fans are not working in synchronism, there must be some interference between the air currents produced by the two fans, whether they are connected in series or in parallel, and this must lead to eddies and to loss of efficiency.

COKE-OVEN GASES.

The two other papers that were of interest dealt with "By-Product Coking Plants." The manufacture of coke in this country has been steadily increasing for some years now, and, in addition, the methods of manufacture are being steadily improved. The old method in which a mass of small coal was thrown into an oven, usually of the beehive shape, ignited, and the gas delivered by the coal allowed to escape through a hole in the top, is rapidly becoming a thing of the past, though at the recent meeting one mining engineer expressed his opinion that it was more economical, when all things were taken into account, to put up beehive ovens than the later pattern of rectangular section ovens, from which the by-products are taken. The objection made to the by-product plant by this gentleman was its great expense. He said it was of no use laying out a large amount of money as you had to in these by-product plants, unless you could see an adequate return, and it was not always easy to do so. Notwithstanding this, by-product coking plant is steadily making its way, and there can be no doubt that this is to the advantage of cheap gas for power purposes, as really the gas is the by-product, not the sulphate of ammonia which is formed from a portion of it, and the more the manufacture of sulphate of ammonia can be developed, the cheaper should the by-product gas become. The small coal is washed and formed into a large cake by means of a stamp in a box provided for the purpose, the stamp being driven by an electric motor. The cake is forced into the oven, which is heated by a portion of the gases that are liberated by the burning coke itself, but the heating gases do not come into contact with the coke that is being operated upon. A portion of the gas liberated by the coal is burnt at the entrance to, and carried through flues, sometimes at the sides and sometimes underneath the oven, and is then passed to a regenerator, consisting of the usual nest of tubes, through which the air that is to be employed in conjunction with the

coke-oven gas in heating the coke ovens is warmed on its way to the burners. It should be mentioned that there are two methods by which the gas from the coke ovens may be employed. The remainder of the gas that has not been used for heating the coke ovens, after being purified, scrubbed, etc., and its ammonia and tarry products removed from it, can be employed for internal combustion engines, its calorific value being in the neighborhood of 400 British thermal units per cubic foot. The gas also which has been employed for heating the coke ovens, and which has been burned in conjunction with air, in the usual way, can also be employed for heating boilers by simply passing the hot gases produced by the combustion of the coke oven gases through the boiler flues. The gas that has not been employed for heating the coke ovens can also, of course, be used for heating the boilers by turning it in the boiler furnace in combination with air in the usual way. The advances that are being made, it will be seen, tend to lower the cost of power considerably, where an electric generating plant can be established in the neighborhood of by-product coking plants.

The Electric Arc.

At the meeting of the London Physical Society on June 14, a paper on the electric arc was read by Mr. Upson, who dealt with observations made during the past session at the Pender Electrical Laboratory, at the suggestion and under the direction of Professor J. A. Fleming, with the object of elucidating some of the facts connected with the production of electric arcs between cooled metal and carbon terminals in air and hydrogen. Apparatus was exhibited for maintaining the arc in various gases, while one electrode was cooled by means of a water circulation. Arcs were described in which the electrodes consisted of carbon, copper, iron and aluminum in different combinations, maintained in air, hydrogen, and coal gas. With 110 volts supply, metal arcs in hydrogen took the form of a spark discharge. At that voltage the maximum length of arc it was possible to obtain, with current up to fifteen amperes, was 0.05 inch, except where both electrodes were of the same metal. When carbon is one of the electrodes a true arc is formed. If carbon is negative the maximum length of arc with the above voltage is 0.07 inch. Volt-ampere characteristic curves were shown for arcs in air and hydrogen of length 0.05 inch. The general position of the curve is determined by the material of the negative electrode. With carbon negative in hydrogen, the curves for various positive electrodes very nearly coincide. With carbon positive they keep the same curvature, but vary in distance apart, according to the material of the negative. In general, the position of the curve is governed by the negative, but its particular shape seems to come from the influence of the surrounding gas. The slope of the curve (amperes horizontal, volts vertical) of the carbon arc in air, is much less steep than that of the curve of any arc in hydrogen. The former curve cuts the latter in the neighborhood of 6.5 amperes. The curve for the arc with carbon positive, aluminum negative in air, is very steep, being equal in this respect to the curves for arcs in hydrogen. Volt-ampere characteristics were shown for copper arcs in air, with (1) positive electrode cooled, (2) negative electrode cooled, and (3) neither cooled. Equations for various arcs were obtained giving the voltage in terms of current and arc-length. It was much more difficult to obtain a carbon arc in hydrogen with alternating currents; and no arc could be obtained when the electrodes were copper positive, and carbon negative, with 100 volts supply and frequencies of fifty and eighty. Similar results were obtained in coal-gas. Apparatus was devised in accordance with a suggestion by Dr. Fleming, to interrupt the arc for a definite period of time. Experiments were tried to determine how long the arc could remain extinguished without losing the power of restarting itself when the electromotive force was again applied. Curves were shown for arcs with electrodes of solid and cored carbons, in air. With cored carbons the time of interruption is greater than with solid, and both are much greater than that for the copper-carbon arc. In hydrogen the copper-carbon arc could not be made to restart itself if the electromotive force was removed for more than 0.04 of a second, and for this arc the minimum interruption possible is far shorter than for any carbon arc in air.

W. Duddell said the paper was a most interesting one. He asked if the author had noted the character of the different arcs which he had used. The characteristic curves for arcs in coal-gas or hydrogen were steeper than those in air, and therefore arcs in coal gas were more suitable for the production of oscillations. He asked if the curves remained steep when the current was quickly changed. He had noticed the phenomenon of an arc between two cored carbons relighting, and said that on high-voltage circuits the length of time was considerable and amounted in some cases to seconds.

Mrs. Hertha Ayrton said the paper was a valuable one, but she was sorry the author had not given a careful description of the appearance of the arcs and carbons under different conditions, and also the observations upon which the curves were founded. It was difficult to arrive at any general conclusions from the author's curves. The steep parts depend not only on the composition of the electrodes but on their size and on the length of the arc. The author had only used short arcs which with carbons only gave the flat part of the curve. With metal carbon you get the steep part. Mrs. Ayrton also expressed her interest in the relighting experiments shown by the author.

A. Campbell asked if the characteristic curve of a mercury arc was similar to that of the other metal arcs investigated. He pointed out that the use of unscientific units (inches and feet) in giving the results of such interesting researches was most deplorable. In all standard work on the subject the lengths of arc are always given in millimetres, and even in commerce the diameters of carbons are similarly expressed (*e. g.* 12 millimetres and not 0.47 inch).

Alexander Russell stated that Mr. Upson's paper would be extremely useful to all engaged in research in connection with the electric arc. He agreed with the author that coal-gas was very unsuitable for experiments with the arc. He had recently been experimenting with high-voltage alternating arcs in coal-gas, and in most cases the enclosing vessel was soon filled with black cobwebs. When, however, the high-voltage, high-frequency arc between iron-iron electrodes was shunted by a Leyden jar in series with a small coil of wire, the discharge between the electrodes became simply a torrent of sparks and no appreciable quantity of soot was formed. The difficulty the author experienced in certain cases in obtaining an arc was due probably to the low voltages used. When high voltages are applied it is easy enough to maintain an arc. More experimental research was wanted on the upper part of the statical characteristic curve of the arc. A good deal of exploration has already been made in this direction in Dr. Simon's laboratory at Göttingen with the help of a motor generator from which three or four amperes of direct current can be obtained at 5,000 volts. The results already obtained were

of great importance. The success of the statical characteristic method as an instrument of research was mainly due to the care with which Mrs. Ayrton has specified the method of obtaining the curve. He hoped that Mr. Upson would make further researches at high voltages.

Dr. Fleming congratulated Mr. Upson on his paper, and said that it represented a considerable amount of careful work, and even if all the conclusions to be drawn from it were not yet absolutely clear, it would furnish a statement of facts which would assist in future theorizing. He said that the interesting part to him at the moment was the difference between the form of the volt-ampere characteristics for the carbon-carbon arc in air and the metal-carbon arc in hydrogen, but on that matter he would defer his remarks until he had shown some other experiments.

Mr. Upson, in reply, stated that the primary object of the paper was to compare metal arcs with carbon arcs. He had also performed some experiments with charge of voltage and variations in the length of burning of the arc, and he hoped to carry out a series of experiments using high voltages.

Experiments were then exhibited by Dr. Fleming, with the Poulsen arc as a means of obtaining continuous electrical oscillations, repeating some of those shown by him at the Royal Institution on May 24 last. Dr. Fleming showed and described an apparatus for forming an electric arc in an atmosphere of coal-gas between a carbon rod kept in slow rotation and a cooled copper anode, the arc being formed in a magnetic field of 600 to 1,000 centimetre-gramme-second units. The arc was supplied with continuous current at a pressure of 400 to 500 volts. A condenser of 0.003 microfarad capacity in series with an inductance of 200,000 centimetres was shunted across the arc, and experiments shown to prove the existence of high-frequency oscillations in the condenser circuit. A long resonance helix of insulated wire was then joined to the condenser circuit, and when tuned to it created a powerful high frequency field round it in which vacuum tubes glowed brilliantly. By vibrating or rotating a Neon vacuum-tube of spectrum type near the helix, and showing that the band or disc of light was cut up by dark spaces, Dr. Fleming supported the contention that the oscillations so produced are not absolutely uninterrupted but cut up into groups. Another experiment was shown to confirm this. The oscillations produced by the arc in one circuit were caused to create secondary oscillations in another circuit in which was a condenser shunted by one of Dr. Fleming's oscillation valves and a telephone. The valve rectifies the secondary oscillations, and if they were absolutely continuous the telephone would be traversed by an uninterrupted direct current. But as a fact a discontinuous sound is heard in the telephone which can arise if the primary oscillations come in batches or groups.

Dr. Fleming then gave some figures showing the kind of values obtained for the efficiency of transformation of continuous to oscillatory current by the arc, and compared them with similar measurements for the spark method. He concluded with some discussion of the *modus operandi* of the metal-carbon arc in the production of oscillations in a shunt circuit containing capacity and inductance. In the first case the curve was (as shown from Mr. Upson's diagrams) much steeper than in the second. This implied that the same amount of energy could be conveyed to the oscillatory circuit by means of a condenser of smaller capacity, and therefore give higher frequency. This was confirmed by the fact that the curve for small currents in the case of the carbon arc in air was steeper than for large currents, and it was found that a Duddell carbon arc could give high frequency oscillations when actuated with small currents. He thought that there was still much work to be done before the whole of the phenomena of the oscillatory arc were understood.

Mr. Duddell expressed his interest in the experiments, especially those in which it was shown that the oscillations were broken up into groups. He pointed out, however, that it was possible to obtain continuous oscillations with a musical arc using high frequencies. The question as to the measurement of the power put into the Poulsen arc was of great interest, as also was the question as to the amount of power which could be taken from the secondary without stopping the arc. He questioned Dr. Fleming's statement that the power put into the arc was equal to the product "AV," and said that the power should be measured with a wattmeter.

Mr. Campbell remarked that Mr. Altberg in Odessa had lately shown that sparks of high oscillation frequency produce actual air vibrations of the same frequency, and by measuring the wavelengths of these air vibrations by diffraction methods he had been able to determine the high frequency.

Dr. Fleming, in reply, said he was prepared to accept Mr. Duddell's criticism that the power put into the Poulsen arc should be measured with the wattmeter. The really important matter, however, was the reason why the metal-carbon arc in coal-gas could produce oscillations of so much higher frequency than the carbon arc in air. This he thought was intimately connected with the slope of the characteristic curve.

Westinghouse Company Makes New High Record.

The report of the Westinghouse Electric and Manufacturing Company for the fiscal year ended March 31 shows net earnings for the twelve months aggregating $5,486,712, or $2,106,981 more than for the previous year. After the payment of all interest charges, sundry adjustments, and allowances for depreciation and development work, the surplus available for dividends was $2,532,200, or $458,420 more than in 1906.

Commenting upon this showing, Mr. George Westinghouse, president of the company, states in his report to the shareholders as follows:

"Owing to the heavy floods in March, the last month in the fiscal year, the company lost considerable ground as it was unable to make shipments except to a nominal extent. Except for this, the showing for the year would have been considerably better than was the case.

"The benefit of the March business was felt in April and May. Partly owing to this and partly owing to the general increase in the volume of business the earnings in April and May were record-breaking.

"The increase of nearly $500,000 in the surplus available for dividends is considerably smaller than normally would have been the case, owing to the fact that, in view of the large earnings of the company, the management decided to write off sundry old accounts not pertaining to the current year's business and to allow more heavily than ever before for general depreciation and development work. To this extent, therefore, the surplus of $2,532,000 does not measure the real surplus earnings of the Westinghouse Company for the late year. Except for the abnormal charges for depreciation and sundry accounts it would have been probably $500,000 greater.

"The results for the two months show a surplus of $432,871 over all interest charges, depreciation, adjustments, ten per cent dividends, etc. This is at the rate of nearly $2,600,000 a year earned over everything. Heavier allowances were made for depreciation, etc., in these two months than ever.

"Of course these two months should not be taken as a criterion of what will be done in the current fiscal year, because they were benefited by the bad weather conditions prevailing in March. However, June earnings continue to show heavy gains. The quarter just closed is the best the company ever had, and the indications are that the current fiscal year will be a record-breaker."

Boiler, Engine and Generator Testing and Management—II.

By Charles L. Hubbard.

Boiler Testing.

THE object of this article is to give briefly and in condensed form directions for carrying on simple tests for determining the power and efficiency of a boiler, and also fuel tests for comparing different grades of coal and methods of firing. These directions are especially for the operating engineer and are not intended to cover all of the points of a long and accurate trial, which should always be in charge of an experienced consulting engineer.

The power of a boiler depends upon the weight of dry steam which it will generate in a given time, regardless of the amount of coal consumed. The efficiency is the ratio of the heat utilized in the process of evaporation to the total heat contained in the fuel burned.

This takes into account the coal consumption as well as the power of the boiler. In making a comparison of the power of two boilers, or the power of a given boiler under different conditions of operation, the efficiency should also be considered as well as the weight of steam generated. A boiler horse-power is the capacity to evaporate thirty pounds of water from an initial temperature of 100 degrees into dry steam at seventy pounds pressure.

In order to make a comparison of boilers working under different conditions from those given above it is customary to reduce them to a common standard called "equivalent evaporation from and at 212 degrees."

A boiler horse-power reduced to these conditions means the capacity to evaporate 34.5 pounds of water from a temperature of 212 degrees into steam at atmospheric pressure. A practical example will make the method of transformation plain.

A boiler carrying 105 pounds gauge pressure receives its feed-water at a temperature of seventy degrees, and evaporates 4,000 pounds of water into steam per hour. What is its equivalent evaporation from and at 212 degrees?

Referring to a steam table we find that steam at 105 pounds pressure has a temperature of 341 degrees, and the latent heat is 874 heat units; then the total heat contained in one pound of steam, above that contained in the feed-water when delivered to the boiler, is $(341 - 70) + 874 = 1{,}145$ heat units.

Therefore, the heat required to raise 4,000 pounds of water from seventy degrees and evaporate it into steam at 105 pounds pressure is $1{,}145 \times 4{,}000 = 4{,}580{,}000$ heat units. The latent heat of steam at atmospheric pressure is 966; therefore, $4{,}580{,}000 \div 966 = 4{,}741$ pounds, the equivalent evaporation from and at 212 degrees.

The ratio $4{,}741 \div 4{,}000 = 1.18$ is called the "factor of evaporation" for the steam pressure and temperature of feed-water given in the problem. Tables giving the factors of evaporation for different combinations of steam pressure and feed temperature may be found in any handbook on steam engineering, and also in many boiler catalogues.

In our definition of boiler power the evaporative capacity is given in pounds of dry steam.

The steam as delivered by a boiler under ordinary working conditions contains more or less water in the form of a fine spray. This is useless so far as doing work in an engine cylinder is concerned, besides being harmful and a considerable source of heat loss if present in any great amount.

It is evident from the above that in making a test for power or for efficiency we must know what proportion of the "steam" delivered by the boiler is vapor and what proportion is water in the form of spray. The percentage of dry steam or vapor is called the quality of the steam, and the process of determining this is called calorimetry.

There are various ways of determining the quality of steam, but perhaps the simplest and at any rate the one requiring the least expensive apparatus is by means of the "barrel calorimeter." While not so accurate as some of the other methods, the results obtained will be sufficiently so for any ordinary tests which the engineer will be likely to make. The barrel calorimeter is made up of a wooden barrel placed upon platform scales, and having a valved connection with the top or side of the steam pipe through a hose, or hose and iron pipe. Means should also be provided for filling with water and for emptying into the drain. The above, together with a thermometer reading to one-fifth of a degree Fahrenheit, completes the necessary apparatus.

The method of using is as follows: the barrel should first be filled with water and warmed up to a temperature of about 130 degrees by blowing steam into it through the hose; draw off the water (which was simply for warming up the barrel), weigh the barrel, and quickly fill with cool water and take its temperature and weight. Next blow steam through the hose into the air to warm and dry the pipe, then insert it in the water, with the end near the bottom of the barrel. Blow steam into the water until the latter reaches a temperature of 115 to 120 degrees, at the same time recording the average pressure on the boiler from which the steam is taken. The pipe or hose should now be removed, the water thoroughly stirred, and the final weight and temperature taken. The quality of the steam will be given by the formula:

$$Q = \frac{\frac{W}{w}(t'' - t') + (t'' - t)}{L}$$

in which

Q = quality of steam.

W = initial weight of the condensing water in the barrel;

w = the weight of the condensed steam, which is equal to the increase in weight of the condensing water;

t = temperature of dry steam at boiler pressure;

t' = initial temperature of condensing water:

t'' = final temperature of condensing water;

L = latent heat of vaporization of dry steam at boiler pressure (taken from a steam table).

Example—The initial temperature (t') of the condensing water is sixty degrees and its final temperature t'', is 120. The steam pressure by gauge is 100 pounds, or 115 absolute, so that its temperature (t) is 338 degrees. The initial weight of the condensing water is 360 pounds; the final weight is 380 pounds. From the above data and by the use of steam tables the values of all the symbols may be filled in as follows:

W = 360;

$w = 380 - 360 = 20$;
$t = 338$ degrees;
$t' = 60$ degrees;
$t'' = 120$;
$L = 876$.

Substituting these values in the formula, we have

$$Q = \frac{\frac{360}{20}(120 - 60) + 120 - 338}{876} = .984$$

which is the quality of the steam; which expressed as a percentage would be 98.4 per cent. The percentage of moisture in the steam, therefore, is 100 — 98.4 = 1.6 per cent.

In computing the efficiency, the heat utilized in evaporation is found by multiplying the number of pounds of feed-water used during the test by the heat units required to change one pound of water at the feed-water temperature into steam at the average pressure carried during the test. For example, with feed-water at sixty degrees and a steam pressure of 100 pounds gauge, (338 — 60) + 876 = 1,154 heat units, would be required per pound of dry steam delivered by the boiler.

In accurate tests the heat units supplied are found by multiplying the total weight of the combustible (weight of dry coal less the ash) by its total heat of combustion; the latter being obtained by means of a fuel calorimeter.

For ordinary approximate tests which are within the scope of this article we may assume one pound of best anthracite coal to contain about 14,000 heat units and a pound of Cumberland coal from 12,000 to 13,000 heat units.

Boiler catalogues and handbooks often give the heat of combustion for quite a variety of different grades of coal in common use, and may be consulted for this information if desired. Before making a test, the specific information sought should be carefully gone over and each step should be planned with this in view. The following general rules applying to boiler tests will be found useful for reference when preparing for any special investigation.

1. Measure and record the dimensions of the grate, heating surface, smoke pipe, and chimney, also the proportion of air-space through the grates.

2. Put the boiler in first-class condition, with all heating surfaces clean, both as regards scale on the inside and soot and ashes on the outside. Have the grates and furnace walls free from clinkers or other obstructions.

3. A sample of the coal should be thoroughly dried and a comparison made, volume for volume, with an undried sample, and the proportion of moisture determined. If the test is for efficiency, the test should be made, if possible, with coal or standard quality whose heat of combustion is known, or a sample may be submitted to an expert for analysis.

4. All apparatus used in the test should be carefully checked and compared with standards, if possible. This applies to tanks, scales, gauges, thermometers, etc.

5. Previous to a test the boiler and chimney should be heated to their usual working temperature, and in case the setting is new, the fires should be run for at least a week before the test is made, in order to thoroughly dry out the masonry.

6. All pipe connections, both steam and water, should be thoroughly tested for leaks, and if any are found, the pipes should be disconnected and capped.

If the boiler is fed by an injector, the steam which it uses must be taken directly from the boiler which is being tested; if a pump is used, the steam for driving it can be taken from any source desired. The steam pipe leading from the boiler should be so graded that the condensation in the same can not drain back into the boiler. If the arrangement is such that this is likely to happen, drip connections should be provided and the water trapped. Important tests should be run for at least twenty-four hours, but for approximate work such as an operating engineer is likely to carry on, a full day of eight or ten hours will give very good results.

There are two common methods of starting and stopping a test, known as the "standard" and "alternate" methods. In the standard method steam is first raised to the normal working pressure, the fire is then drawn and all ashes and other refuse removed from the ash-pit. A new fire is at once started, record being kept of the weight of wood and coal used for this purpose. At the close of the test the fires are drawn and the ash-pit cleaned in a manner similar to that at the start. Care should be taken to have the water-level in the boiler the same at the end of the test as in the beginning. The alternate method is better adapted to simple tests of the kind under discussion, as it is easier to carry out and interferes less with the regular working of the plant.

In this case the fires are allowed to burn rather low, then thoroughly cleaned, and the quantity of coal left on the grate is carefully noted. The time of starting the test is then recorded; also the steam pressure and the height of the water in the gauge-glass, the latter being marked by means of a string tied around the glass. Coal from a pile which has been weighed should then be fired, after which all refuse from the ash-pit should be removed. All conditions should be kept as nearly constant as possible during the test, and the boiler should be run continuously without stopping for meal-time or rise in pressure due to a decreased demand for steam. The draft should be kept as nearly constant as possible in order to give the desired rate of combustion throughout the run.

If the boiler is on an independent line of piping it should be provided with an extra valved outlet, so that any temporary excess of steam can be blown off and the pressure reduced. If the boiler is one of a battery discharging its steam into a common main, the safety-valve should be set a little higher than those on the other boilers in order to prevent any backing of steam into the boiler being tested, as might be the case if its safety-valve should lift before the others in the battery.

The time of cleaning the fire will be governed to some extent by the quality of coal and the rate of combustion. Under ordinary conditions with a good grade of coal an eight or ten-hour test may be made without cleaning except just before and after the run.

If a poor grade of fuel is used so that clinker forms to a considerable extent, the fire should be cleaned at regular intervals.

The coal should be delivered to the fireman regularly and in quantities sufficient to last about an hour. These portions should be of equal weight, and should only be delivered as fast as used. The time of delivering each fresh portion should be noted so that a comparison of the time required to burn each one may be made in order to determine the evenness of combustion.

The coal should be weighed in barrows or barrels and may be dumped upon the floor, or the firing may be done directly from the barrows if they are of convenient form. The weight of the barrow should be subtracted from each load, and the weight of coal remaining unused at the end of the run must be weighed and subtracted from the total delivered. Near the end of the test the fires should be allowed to burn down and should be cleaned as at the beginning of the test, care being taken to leave the same amount of coal upon the grate as at the start.

One of the most convenient methods of

measuring the amount of feed-water supplied is to weigh it in barrels upon accurate platform scales. This is best done by having two large barrels placed upon scales, and at an elevation sufficiently high above the tank from which the boiler is fed so that they may be readily emptied into it by gravity. One barrel can be filled while the other is being emptied. The weight of each, less the weight of the barrel, should be recorded and the water-level in the feed tank should be the same at the beginning and end of the test. The temperature of the feed is usually taken by means of an oil-cup thermometer screwed into a tee in the feed-pipe near the boiler. If the temperature remains nearly uniform, readings may be taken at fifteen-minute intervals, but if there is much variation they should be taken oftener. The water-level and steam pressure should be kept as nearly constant as possible; readings of the latter being taken at frequent intervals the same as for the temperature of feed-water. The strength of the chimney draft may be obtained by the use of a U-tube partially filled with water. A rubber tube is attached to one leg of the tube and inserted in the chimney through a small hole drilled for this purpose, while the other leg of the tube remains open to the atmosphere. The difference in the level of the water in the two legs of the tube indicates the intensity of the draft.

For example: a difference of one-fourth inch indicates a moderate draft, and three-eighths inch to one-half inch very strong for a natural draft.

Having shown in a general way the method of procedure and the principal data to be obtained, let us apply it to a practical example.

DATA.

Heating surface, 2,200 square feet.

Grate surface, 50 square feet.

Ratio of grate to heating surface, 1 to 44.

Kind of fuel, anthracite.

Length of run, 8 hours.

Rated horse-power, 250.

FROM OBSERVATION.

Steam pressure (average) 110 pounds (gauge).

Chimney draft, 0.2 inch of water.

Temperature of feed-water, 60 degrees.

Pounds of coal burned, 5,500.

Pounds of refuse, 460.

Pounds of water fed to boiler, 58,000.

Quality of steam from calorimeter, 98.5 per cent.

COMPUTED.

Pounds of combustible, 5,500 — 460 = 5,040.

Proportion of refuse, 460 ÷ 5,500 = 0.091, or 9.1 per cent.

Coal burned per hour, 5,500 ÷ 8 = 687 pounds.

Coal burned per square foot of grate per hour, 687 ÷ 50 = 13.7 pounds.

Total water evaporated, 58,000 × 0.985 = 57,130 pounds.

Water actually evaporated per pound of coal, 57,130 ÷ 5,500 = 10.4 pounds.

Water actually evaporated per pound of combustible, 57,130 ÷ 5,040 = 11.3 pounds.

Factor of evaporation, 1.2.

Water actually evaporated per pound of combustible from and at 212 degrees,

$$\frac{57{,}130 \times 1.2}{5{,}040} = 13.5 \text{ pounds}$$

Horse-power developed during test,

$$\frac{57{,}130 \times 1.2}{8 \times 34.5} = 248.$$

EFFICIENCY OF BOILER.

Assuming each pound of coal of this grade to contain 14,000 thermal units, the total heat given up by the coal is 5,500 × 14,000 = 77,000,000 thermal units.

The total heat absorbed by the boiler = 57,130 pounds of water evaporated under actual conditions multiplied by 1.2 (factor of evaporation) × 966 (heat of vaporization at 212 degrees) = 65,565,096 which corresponds to an efficiency of 65,565,096 ÷ 77,000,000 = 0.85 or 85 per cent.

In making tests by the methods described, the engineer can make use of only such parts as he desires, depending upon the information sought, and so simplify the process somewhat from that given above if desired.

Circuit Court Overrules Demurrers of Interborough-Metropolitan Company.

Judge Holt in the United States Circuit Court has overruled the demurrers of the Interborough-Metropolitan Company and other defendants in the suit brought by Daniel W. Burrows. Judge Holt has decided that there is a cause for action and that a practical monopoly has been established by the Interborough-Metropolitan Company. The object of the suit is to set aside the transfer of certain stock of the Metropolitan Securities Company to the Interborough-Metropolitan Company.

The court holds that the facts set forth do not constitute any violation of the penal code, but says that the principal question involved is whether they do constitute a violation of the corporation law.

NOTES ON THREE-PHASE TRACTION.[1]

BY GERARD B. WERNER.

THE ELECTRIFICATION PROBLEM IN GENERAL.

The substitution of electricity for steam as motive power for train haulage is today contingent on financial and not technical considerations. There are at present three electric systems worthy of attention, and the engineering difficulties incurred in the development of each may be fairly said to have been overcome. The question, then, of the adoption of electric traction by steam railroads becomes a question of reduced operating costs or increased earning capacity.

The electric equipment required for trunk line service involves a very great investment. The writer has in mind a project for the electrification of an 80-mile, double-tracked section, with an annual traffic of about 1,500,000,000 ton-miles, which called for the expenditure of approximately $2,500,000 (deducting the value of the steam locomotives replaced The fixed charges on this capital must, of course, be charged to the operating expenses, and still a material saving must be effected in order that a respectful hearing may be accorded to the proposition by the railroad management. The analysis of the cost of steam and electric locomotive operation formed the subject of a paper recently contributed by the writer to the technical press.[2]

STRUCTURAL FEATURES OF THE THREE-PHASE LOCOMOTIVE.

The current collectors consist of two long rollers mounted on the same wooden shaft, and rotating in ball bearings. The current is taken from them by carbon brushes. They give a broad contact surface of 24¾ inches for each phase, the distance between the two wires being about three feet. Four years of actual service on the roads of Germany, Switzerland and Italy have proven the claims made for this construction, *viz.*:

It combines the advantages of the trolley wheel in rolling friction with the broad contact of the Siemens bow.

It is perfectly safe and practically sparkless even at 200 amperes at forty miles an hour, and 100 amperes at sixty miles an hour.

In the latest form of a steel tube contact cylinder, covered by a sheet of electrolytic copper, it is good for 12,000 locomotive miles. The maintenance and re-

[1] From a paper read before the Electrical Engineering Society of Columbia University.

[2] *Engineering Magazine*, March, 1907. Also ELECTRICAL REVIEW, March 23, 1907.

pairs are consequently small. The abrasion on the trolley wire is minimized, no sign of wear being visible except a polished surface about one-thirty-second inch broad on the under side.

The current collectors are actuated by compressed air, and the pressure against the working conductor is adjusted to the running speed.

As will be pointed out further on, the intermediate speeds on the controller are secured by the insertion of resistance in the rotor circuits. The Valtellina line uses water rheostats instead of the usual metallic grids. Compressed air moves the water to and from the contact plates, thereby producing a variable resistance. The pneumatic valves are actuated by relays from the main controller. The advantages of the water rheostat are lighter weight and less repairs. Burnouts are not possible, since the overload capacity is large. Starting can also be effected more smoothly in the absence of the coarsely graduated steps of the metal resistances.

Another unique feature of the three-phase locomotive is the driving mechanism. For motors of several hundred horse-power gears are not admissable, since they involve difficulties of design, occupy valuable space, and increase the energy consumption by about three per cent. Direct coupling is a satisfactory solution for motors of the series type. But with induction motors, where, on account of the distributed winding, no vertical movement is possible and the case is in one piece, the wheels would have to be pressed off the axle to make the motor accessible for repairs. The motors of the three-phase locomotives are mounted between the driving axles and drive the axles by crank-pins and coupling rods.

The advantages of this drive are (1) the facility of removing the motor for repairs; (2) the collector rings and brushes are outside the locomotive frame, and readily accessible for inspection; (3) the danger of the motors sharing the load disproportionately is obviated, since all the axles are driven at the same speed (which would not be the case if the axles were driven separately and there was a small difference due to wear in the diameters of the drivers); and (4) the energy loss in the mechanism is small.

THE INDUCTION MOTOR PER SE.

In point of efficiency, the induction motor is far superior to the series motor either of the direct-current or single-phase type. The efficiency of the latter two may reach eighty-eight per cent and eighty-four per cent respectively, while that of the induction motor for railway service is about ninety-five per cent in single connection. At starting, in cascade connection the efficiency is about eighty-eight per cent.

Similarly, the power-factor in single connection and cascade is about ninety-three per cent and eighty-five per cent respectively for all loads above one-quarter of the rating. These figures may be compared to those of the New Haven motors, which vary from seventy per cent to ninety-two per cent throughout the range of loads.

In point of weight, for the same conditions of speed and output, the three-phase motor weighs only about eighty per cent of the direct-current, while compared to the single-phase, the difference is still more marked. The cost, which may be taken proportional to the weight, is correspondingly lower.

With regard to starting torque, the induction motor can develop any tractive effort up to full adhesion weight, by starting with the rotor resistance. The induction motor moreover can utilize a constant input up to the maximum running speed. This fact enables the induction motor to attain a high average acceleration.

The overload capacity of the induction motors for railway service (in 500 horse-power to 750 horse-power sizes) greatly exceeds that of the series motors. The pull-out torque for induction motors of this size is six to seven times full-load torque, and this overload capacity is attained without any special liberality of design.

With regard to mechanical structure, the induction motor, with its compact design, its windings encased in hermetically sealed tubes, and its collector rings instead of commutator, presents a much more rugged character than the series motors of the continuous current or one-phase type.

SPEED CONTROL.

Both with direct-current and three-phase motors, the economical running speeds are limited to two or three; and all intermediate speeds are obtained only by rheostatic connections. Instead of connecting four direct-current motors in series, then two multiple groups of two in series, and then four in parallel; three induction motors may be connected in cascade, then two in cascade, and then two or three in multiple—in both cases three running speeds being obtained, and the same amount of power saved.

In the cascade or concatenation control, the secondary of the first motor is connected to the primary of the second motor, and the secondary of the second motor to the primary of the third motor, and the secondary of the third motor is connected to the rheostat. The speed under these conditions will correspond to the total number of poles in the cascade. Thus, if at twenty-five cycles, the motors in concatenation have four, six and ten poles, each will run at 150 revolutions a minute.

CONSTANT-SPEED CHARACTERISTIC FOR RAILWAY WORK.

In urban service where the greater part of the time is occupied in starting and stopping, and where the runs are so short that the maximum speed is of little consequence, the series motor presents an admirable solution. But, as the distance between stops is lengthened and trunk line conditions are approached, the time consumed in accelerating is relatively small, and a motor which will maintain a given speed independent of gradients is much more effective from the point of view of the railroad operator. A motor with inherent variable speeds is no longer necessary, and in fact of no distinct advantage. Of course, the competitor of the series motor must possess equal characteristics in overload capacity response without injur

It is claimed, however, that if the train is to run at the same speed on grade and level, the power required when running on the grade will be correspondingly greater, and that the peaks occasioned by these conditions will be excessive, and the load-factor very low. It is admitted that a poor load-factor is not conducive to economy, not only on account of the poorer efficiency of the generating and converting units at fractional loads, but also on account of the fixed charges being independent of the output. But it must not be assumed that the constant-speed characteristic of the three-phase system will result in more unfavorable load fluctuations than any other system. These fluctuations will of course depend on the time-table and the profile, but there are three considerations that should be borne in mind. First, for heavy grades, say between 0.8 per cent and 1.5 per cent the lowest or intermediate speed may be used, and the power required reduced correspondingly. Second, the power required for ascending the lighter grades generally will not exceed the power required for accelerating. For example, the power required to accelerate a 300-ton train on the level at 0.56 mile per hour per second is the same as that required to drive the train at seventy miles an hour on a 0.34

per cent grade or at forty miles an hour on a 1.7 per cent grade. Now since the whole system is designed for the maximum demands, occasioned by the heaviest trains accelerating, no additional investment in copper conductors or machinery is necessitated by the constant speed and variable power characteristics of the three-phase motor, nor will the peaks occasioned by grades on the average exceed the peaks due to the trains starting. Third, another influence which tends to equalize the load variations is the recuperation feature, which is unique with the three-phase system. With a fair density of traffic, the excess of power required by the ascending train will be furnished by the power generated by the descending train in the neighborhood.

THE VALUE OF RECUPERATION.

It is an inherent characteristic of the induction motor that when the torque becomes negative and the speed rises above synchronism, it acts as a generator, returning energy to the line. This feature is utilized in the three-phase system to conserve the energy which would otherwise be wasted when running on down-grades and during braking.

Recuperation with induction motors is effected automatically and without any complicating devices. The per cent of the available kinetic energy of the moving train that can be recuperated during coasting or braking depends upon the train resistance and the efficiency of the motors, and it is difficult to state this in a generalization. The amount of the available recuperated energy that can be utilized by trains in the vicinity running on the level or on up-grades, will depend on the line losses between the point where the energy is liberated and the point where the energy is utilized. With a fair degree of traffic, eighty per cent to ninety per cent of the available recuperation can be made use of for train propulsion. The final value of recuperation lies in the fact that the watt-hour per ton-mile consumption is reduced from ten per cent to forty per cent, varying with the degree of the various influences present.

TWO OVERHEAD TROLLEY WIRES.

Perhaps the objection requiring the most serious consideration that is urged against the three-phase system is the use of two overhead working conductors. It is claimed that this arrangement costs more, and that it entails difficulties in operation at switches and cross-overs.

A three-phase distribution for the same voltage, power transmitted and allowable losses, requires only seventy-five per cent as much copper as the single-phase system; so that the additional investment required for the suspension and insulation of the two wires will be compensated by the saving in weight of copper.

In point of operating cost, assuming the same initial cost for both the three-phase and single-phase overhead systems, the fixed charges will be about the same. In the item of repairs, the material will naturally be greater for two wires than for one. But the heaviest charge for repairs and maintenance is the labor item of periodical inspection, which will be the same in both systems per mile of track, since the same crew can look after two wires equally as well as one.

In regard to operation difficulties at switches and cross-overs, experience has shown, on the Valtellina line and in the Simplon tunnel, both of which present complicated switching yards, that the design difficulties of the overhead construction have been solved. The two wires are suspended from a single support, and the two contacts of the current collector are also mechanically comprehended in a single structure.

Static Balancers.

The use of static balancers for supplying three-wire systems from two-wire dynamos is discussed in the *Electrical Review* (London), June 14 and 28, by C. G. Garrard. The author first explains the principle of the balancer, which is merely an inductance placed across taps taken from the armature of the generator. This may be either a single-phase or three-phase arrangement, the neutral wire being connected to the central point. The design of balancers is taken up, and it is shown that in general the iron core should be rather large in area, and short in length to give the maximum inductance. When properly designed there will be practically no magnetic leakage due to the alternating voltage in the balancer. However, as soon as out-of-balance continuous current begins to flow back through the balancer, the conditions are altered, as there thus is caused a superimposed continuous-current magnetization, the amount of which depends upon the type and design of the balancer. This may be overcome by winding the neutral conductor around each leg a sufficient number of times to neutralize the continuous-current magnetization, but this method increases the weight of material in the balancer and makes it more difficult to design. In systems where direct current is supplied from a rotary converter the balancer may be discarded and the middle wire run to the neutral point of the transformers. The theory of this system is exactly the same as that of the static balancer, but if there is a considerable amount of out of balance to be dealt with it is probable that a special balancer connected to the slip rings of the rotary will be cheaper and more efficient. A short, thick design is most suitable for the balancer, and this is just the opposite of best conditions for a transformer design, in which it is generally desired to have as little reactance as possible. The amount and proportions of the iron in the transformer are fixed from the transformer point of view, and the increase of iron loss due to out-of-balance current would be much greater than if a special balancer were used. Therefore, the overall efficiency of the system would be lowered and the temperature rise of the transformers would become excessive. A static balancer capable of dealing with an out-of-balance current of 200 amperes on a 480-volt three-wire system is a small affair corresponding to a thirty-four-kilowatt, three-phase transformer with half the copper removed. If the out-of-balance current were ten per cent, this would be on a system of 960 kilowatts, necessitating one 1,000-kilowatt, three-phase transformer or three 333-kilowatt, single-phase transformers to feed to rotary. The provision of a small balancer to return the out-of-balance current to the rotary with relatively small losses would result in comparatively small losses; whereas, to pass it through the transformers would result in much larger losses. Where it is possible to use a six-phase balancer, by suitable connections complete neutralization of the continuous-current magnetization is possible without extra windings, and much better balancing may be obtained than with either the three-phase or single-phase arrangement. Static balancers are usually tested by applying an alternating current of the proper potential, and then passing a direct current through one side. Where three-phase balancers are employed two may be connected up in opposition in order to make a loading-back test. The author points out that the cause of the increased iron losses due to direct-current magnetization is not very well understood. It is supposed to be due to the leakage flux set up by the direct current, which causes iron losses in the iron core.

High Electromotive Force and Its Application to the Study of Powerful Electrical Discharges.

Dr. John Trowbridge has reprinted, in pamphlet form, his recent contribution to the Memoirs of the American Academy of Arts and Sciences, on "High Electromotive Force; Its Application to the Study of Powerful Electrical Discharges, and Spectrum Analysis."

For some years past Dr. Trowbridge has been working with high potentials obtained by means of a storage battery consisting of 20,000 cells of the lead sulphuric acid type, and he here describes the difficulties met in its construction. The size of the cells is such that for a few seconds a current of eight amperes may be drawn from them at a potential of 40,000 volts.

When using the battery to charge a condenser through a high resistance, the condenser becomes charged fairly slowly, then discharges, and again recharges. This takes place with remarkable regularity, and the time of a discharge can be regulated at pleasure by means of the resistance, so that the battery thus arranged serves as a sort of electrical clock.

Work with this battery leads the author to remark that to the electrician the physiological theory of electrical currents in muscles and nerves is incomprehensible and not in touch with any phenomena exhibited by voltaic batteries or electrical machines. For a collection of muscles or nerves, which are apparently homogeneous in nature, or at least do not show such a marked difference in the chemical construction, can produce, it is said, an electric spark and shocks of considerable severity. If there exists in the separate muscle a source of electricity, what is the mechanism by means of which the muscles can be discharged in series, for the electromotive force of each muscle must be exceedingly low, and the high electromotive force of the electrical cell must be obtained by some mechanism which enables the animal to throw the effect of each muscle in series with the neighboring muscles. It can not be supposed that these animals exhibit a phenomenon like that shown in a thunder cloud. For the theory of animal electricity to be accepted by the electrician, it must be shown how circulation takes place, and how the series coupling is carried out.

Dr. Trowbridge has used this battery for obtaining photographs of powerful electrical discharges. He shows that a brush discharge occurs at each angle of a zigzag discharge. This may be a sort of explosion, and he suggests that it may, in some way, give rise to the rolling effect of thunder. He describes also a means by which a negative showing a weak impression may be intensified so as to bring out strongly all of the image.

This battery has also been employed for spectrum analysis. When the discharge of a powerful condenser takes place between metallic terminals within glass tubes filled with rarified gases, it is found, in general, that the strong lines of the metals employed as terminals are reversed. It is only when the metallic terminals are close together that this phenomenon is observed. When the discharges take place in air no spectroscopic evidence of the metals of the spark terminals can be obtained at a distance of three inches from the terminal. Evidently the environments have some effect upon the character of these spectra and this throws some doubt on the entire subject of spark spectra. Even when a spark spectra is shown between metallic terminals in an atmosphere of hydrogen or nitrogen, it is not certain that the results are not modified by the gases which are occluded in the metallic terminals.

Hydroelectric Power versus Steam for Industrial Plants.

The proper method of making an engineering study of a water-power project is discussed in this one of a series of articles on hydroelectric power by H. von Schon. An analysis of a hydroelectric power project involves principles of topographical, hydraulic, mechanical and electrical engineering. For this reason the projection, design and construction of such plants form a distinct engineering specialty. It is only rarely that conditions are such that the most satisfactory site and scheme of development can be determined by a merely cursory examination. It generally becomes necessary to study carefully a considerable reach of the water course to determine the best location, and the selection of the latter depends largely upon a correct understanding of the topography of the river valley and its geological character. Such knowledge can be gained by means of extensive surveys and borings, but the time and cost involved in such operations are usually not available. The information must therefore be gained from a general reconnaissance, during which the topography and geology become pictured, so to speak, upon the mind trained to estimate their influence upon the project under consideration. The location being selected, the scheme of development must be determined, and this may be solved either by direct development or by distant diversion. It is not always desirable to concentrate a fall exceeding twenty-five to thirty feet at one place, as the cost and weight of a dam increase rapidly above that height, and the enlargement of the flowage area may necessitate the purchase of costly land. The successful designing of works can be accomplished only when accurate data as to the extreme conditions to be expected in flood time are to be had. The author gives an analysis of the water sources of different sections of the country, and shows that for northern rivers the monthly run-off can not exceed from 1.25 to three per cent of the annual precipitation. For eastern rivers it is from one to 0.15 per cent; for southern rivers, 0.25 to 0.12 per cent, and for western rivers, 0.16 to 0.1 per cent. In all cases a careful survey of the drainage basin should be made, and the work decided upon only after data covering several years' observation have been compiled. When the least monthly flow has been thus determined, the possibilities of storage should be considered, and if the low month comes between two months of fairly high flow it may be possible to increase considerably the flow during the low month. The author discusses the question of available fall, and shows that it may often be desirable to divert the latter either by a canal and tunnel or a pipe rather than to erect a high dam. The type of equipment selected depends upon the height of fall. Up to about thirty-five feet the turbines are most economically placed in open chambers; up to eighty feet, the reaction turbine meets requirements; beyond that the impulse type is most suitable. Whether the turbine unit is to consist of one or more wheels is to be decided by a comparison of the respective costs of the complete hydraulic and electric power unit. The distance to which power may be transmitted depends upon the amount. As a general rule there should be 100 horse-power for each mile of line. The loss in transit should be kept below ten per cent. Generally speaking, an investment of from $160 to $180 a horse-power delivered will show a net earning of from six to eight per cent. These are rather high cost figures, as the greater number of hydroelectric developments range from $125 to $150. The value of these investments, however, is more liable to increase than otherwise, since every indication points to a rise in the price of power service in all branches of industry.—*Engineering Magazine, July.*

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION.

SEVENTH ANNUAL CONVENTION OPENED IN NEW YORK, JULY 17.

For the seventh annual convention of the National Electrical Contractors' Association of the United States, members and others whose interests merge into the proceedings of this important association began to gather at the Imperial Hotel, New York city, the official headquarters, as early as Sunday and Monday July 14 and 15 although the general convention did not open until Tuesday morning.

On Tuesday morning, July 15, an executive session of the National Board of Directors was held at 10 o'clock at the Imperial Hotel. This was followed by an afternoon session of this committee and the routine executive work incident to the association was taken up.

On Tuesday evening this committee spent the evening at Hammerstein's Roof Garden.

An interesting entertainment was provided, which included a banquet at the Waldorf-Astoria on Wednesday, a smoker and vaudeville at Shanley's restaurant on Thursday evening, and on Friday an excursion and a Rhode Island clam-bake will occur at Witzel's Point-View Island, to which the entire day will be given.

The convention was called to order Wednesday morning somewhat after the hour scheduled, in the assembly room of the new Engineering Societies Building. J. C. Hatzel, chairman of the convention committee, was in the chair. Mr. Hatzel introduced James Hilton, president of the Electrical Contractors' Association of New York State, who made an address of welcome. Following this occurred the introduction of James R. Strong, president of the National Electrical Contractors' Association, by Mr. Hilton.

Mr. Strong then took the chair and Professor Geo. F. Sever, consulting electrical engineer of the city of New York, made an address on "The Relations of New York City with the Electrical Contractor."

Arthur Williams, ex-president of the National Electric Light Association, followed with a paper on "The Central Station's Relations with the Contractor." Following this Mr. J. Robert Crouse, secretary of the Cooperative Electrical Development Association, spoke on "Cooperation." A full report of this meeting will be published in the next issue of the ELECTRICAL REVIEW.

By request of the National Committee of the Associations the ELECTRICAL REVIEW presents herewith a list of the manufacturing companies to which special thanks is given by the association for contributions to the entertainment fund:

Alphaduct Company, Jersey City, N. J.

American Circular Loom Company, Chelsea, Mass.

American Conduit Manufacturing Company, Pittsburg, Pa.

Ames Iron Works, Oswego, N. Y.

Ansonia Electrical Company, The, Ansonia, Ct.

Ball & Wood Company, New York city.

Barnard & Company, B. S., New York city.

Benjamin Electric Company, Chicago, Ill.

Bishop Gutta Percha Company, New York city.

Bossert Electrical Construction Company, Utica, N. Y.

Bryant Electric Company, The, Bridgeport, Ct.

Condit Electrical Manufacturing Company, Boston, Mass.

Corey Company, R. B., New York city.

Crescent Company, Valparaiso, Ind.

Crouse-Hinds Company, Syracuse, N. Y.

Dale Company, New York city.

DeVeau Telephone Manufacturing Company, New York city.

D. & W. Fuse Company, Providence, R. I.

Edwards & Company, New York city.

Electric Storage Battery Company, Philadelphia, Pa.

Emerson Electrical Manufacturing Company, St. Louis, Mo.

Faries Manufacturing Company, Decatur, Ill.

Fort Wayne Electric Works, Fort Wayne, Ind.

Frink, I. P., New York city.

General Electric Company, Schenectady, N. Y.

Goulds Manufacturing Company, The, Seneca Falls, N. Y.

Harrisburg Foundry and Machine Works, Harrisburg, Pa.

Hart Manufacturing Company, Hartford, Ct.

Hart & Hegeman Manufacturing Company, The, Hartford, Ct.

Highland Electro-Chemical Manufacturing Company, Connellsville, Pa.

Holophane Glass Company, New York city.

Horton-Morehouse Company, Detroit, Mich.

Hotel Imperial, New York city.

India Rubber and Gutta Percha Insulating Company, New York city.

Johns-Manville, H. W. Company, New York city.

Krantz Manufacturing Company, Brooklyn, N. Y.

McIntosh, Seymour & Company, New York city.

Mark Manufacturing Company, Chicago, Ill.

Marshall Electric Manufacturing Company, Boston, Mass.

Mullin, Colman J. Company, Brooklyn, N. Y.

National Carbon Company, Cleveland, Ohio.

National Electric Lamp Association, Cleveland, Ohio.

National India Rubber Company, Bristol, R. I.

National Metal Moulding Company, Pittsburg, Pa.

National X-Ray Reflector Company, Chicago, Ill.

New York Edison Company, New York city.

New York Slate Works, New York city.

Okonite Company, The, Ltd., New York city.

Paiste, H. T. Company, Philadelphia, Pa.

Partrick, Carter & Wilkins Company, Philadelphia, Pa.

Pass & Seymour, Inc., Solvay, N. Y.

Peru Electric Company, Peru, Ind.

P. R. Manufacturing Company, Detroit, Mich. Successor to Proctor Raymond Manufacturing Company.

Providence Engineering Works, Providence, R. I.

Quimby, William E., Inc., New York city.

Roebling's Sons Company, John A., New York city.

Safety Insulated Wire and Cable Company, Bayonne, N. J.

Safety Armorite Conduit Company, Pittsburg, Pa.

Sears, Henry D., Boston, Mass.

Sprague Electric Company, New York city.

Steel City Electric Company, Pittsburg, Pa.

Sterling Conduit Company, Troy, N. Y.

Standard Underground Cable Company, Pittsburg, Pa.

The Metropolitan Switchboard Company, New York city.

The Diamond Rubber Company, Akron, Ohio.

The Perkins Electric Switch Manufacturing Company, Bridgeport, Ct.

Thomas & Betts Company, New York city.

Tibbals, E. C. & Company, Brooklyn, N. Y.

Trumbull Electric Manufacturing Company, Plainville, Ct.

Walker Company, Philadelphia, Pa.

Waterbury Company, Waterbury, Ct.

Western Electric Company, New York city.

Weston Electrical Instrument Company, Newark, N. J.

Among prominent men present representing manufacturing interests, the following were in evidence on Monday and Tuesday:

Alex. Henderson, S. B. Condit, Jr., E. G. Bernard, A. T. Clark, Oscar Hoppe, Robt. Garland, John W. Garland, J. M. G. Fullman, Jas. Dolier, Milton Hartman, H. B. Kirkland, H. B. Crouse, C. E. Corrigan, V. C. Gilpin, Bert Hills, Chas. Crofoot, F. C. Hawkins, Jno. W. Brooks, W. B. Hall, A. M. Little, A. H. Spahn, F. S. Baldwin, Chas. F. Boyton, R. E. Schoenberg, Thos. H. Bibber, O. J. Bryan, Oscar Carman, E. P. Eckert, C. A. Flack, Arthur Frantz, H. S. Greene, B. G. Kodjbanoff, Jno. J. Myers, M. F. King, Chas. F. Machen, J. B. Olson, Geo. C. Richards, E. W. Rockafellow, W. P. Crockett, W. S. Sisson, Albert S. DeVeau, R. B. Corey, R. C. Wilson, D. A. Waterman, Robert L. Jaynes, John W. Brooks, F. W. Bliss.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Loading Stationary Induction Apparatus for Heating Tests.

Various arrangements for conducting heat tests of transformers intended to avoid an unnecessary loss, are described here by G. C. Shaad. When two similar transformers are to be tested, the most common arrangement is to connect the low-tension or secondary coils in multiple across a source of potential, to connect the primaries in opposition, placing in the same circuit a coil of a small auxiliary transformer, the voltage of which can be varied by means of a suitable resistance or otherwise. The exciting current and iron losses are then supplied to the secondary coils, while the load current losses are supplied by means of the auxiliary transformer. Where there is but a single unit to be tested it is often possible to form a combination of shop transformers of a different voltage rating in such a way that a part at least of the energy represented by the full load of the transformer under test may be returned to the source of supply. For example, a 13,200-volt-350-volt, 300-kilowatt transformer may be loaded by means of two 200-kilowatt, 6,000-370-volt transformers if the latter be connected in series, although this arrangement throws a somewhat increased strain on the high-potential coils of the two auxiliary transformers. When there are three single-phase transformers of the same type to be tested, two of these may be connected up and tested, and during this time the secondary of the third may be connected in series in the secondary circuit, and thus be partially heated, so as to save time when its turn for testing comes. Or if a three-phase source of energy is at hand, the three secondaries may be connected in delta, the primaries connected up in series, and the current through them be varied by a fourth auxiliary transformer with small rating. This arrangement may be used also with the auxiliary transformer replaced by a potential regulator. When a three-phase transformer is to be tested, intended for Y connection, it should be tested for the corresponding conditions with the coils connected in delta, the final connection being made without the heat test. Feeder regulators which are adjusted by varying the number of turns either of the primary or secondary windings may be loaded for test as transformers. Single-phase induction regulators or magnetic regulators may be loaded by connecting the primaries in multiple and applying normal potential while the secondaries are connected in series opposing. One regulator is kept in the position of maximum increase in voltage, and the other is varied until full-load current flows in the secondaries. Under this condition the difference in primary currents may be considerable, since the air-gap causes such apparatus to have a large magnetizing current. Three-phase and six-phase induction regulators may be connected up for heat runs in a similar manner. The primaries are placed in multiple, and supplied with the proper potential. The secondaries may be connected in Y opposing. The regulators are adjusted until full-load current flows in the secondaries, when normal voltage is impressed upon the primaries. In all heat run tests on apparatus of this nature much time may be saved by starting the test at an overload or without having the cooling devices in operation.—*Abstracted from the Electric Journal (Pittsburg), June.*

On the Loss of Energy in the Dielectric of Condensers and Cables.

The loss of energy that takes place in solid and liquid dielectrics situated in a periodically varying electric field at present arouses interest equally from physical and technical points of view. The latter's interest has increased considerably the last few years, as higher voltages have been brought into use. Dr. Bruno Monash discusses in the first section of this contribution the methods which have been employed for measuring this loss, and describes in some detail a particular method which he himself has been using. Since 1864 it has been known that a dielectric placed between the plates of a condenser would become warm if the latter was charged and discharged continually. Regarding the cause of this heat, two opinions have been advanced. Steinmetz attributes it to a sort of molecular friction, and calls it dielectric hysteresis. The other view seeks to explain the loss by the presence of some conduction phenomenon, perhaps of an electrolytic kind, or of the kind of loss taking place in a resistance. The experimental investigations concerning the question of hysteresis were rendered difficult by the viscous effects connected with the formation of residual charges, and in so far as they attempted the proof of true static hysteresis in the sense of a phenomenon independent of the speed of alteration of the field, most of them gave negative results. M. de Hoor, however, using a specially prepared paper, succeeded in obtaining a regular static hysteresis—that is, a constant loss per cycle, even at very low frequencies. It is possible, however, to determine the laws followed by this loss in alternating or revolving electric fields, and it has been with this object in view that the greater number of experimental investigations have hitherto been carried out. The question turns principally upon the dependence of the loss on the voltage or the intensity of the field, and on the frequency. The results of these inquiries differ extremely, and are contradictory one to another, especially as regards the influence of the intensity of the field. Several experimenters have obtained results indicating that the loss is proportional to the square of the intensity of the field when the field intensity is low, while in strong fields it increases more rapidly than the square. The figures obtained vary from 1.5 to three. More recently the opinion has been repeatedly expressed that the loss can not be given as proportional to a power of the strength of the field with a constant exponent at all, and at present we can not form any conclusive opinion as to the sort of connection between the energy loss in dielectrics and the intensity of the electric field. The technical interest in the subject was confined until a few years ago to the fact that the heating of condenser subjected to an alternating pressure was thought to be a drawback in itself on account of the energy loss accompanying it. For the most part, these condensers were made of prepared paper or other fibrous material, and owing to the comparatively high losses, they became hot so easily as to be ruined as soon as they were subjected for any length of time to an alternating pressure of more than a few hundred volts. Later more suitable materials were introduced as dielectrics, thus reducing

the loss and making it possible to employ condensers for higher potentials, and as these have come more into use, the causes and the laws governing the losses which take place in them have become of even greater interest. This is true of the field of wireless telegraphy and also in transmission practice, when it becomes necessary to employ cables. The latter phase of the subject is becoming of great importance in Europe, where much of the high-tension transmission must be done by underground conductors. In such networks the dielectric loss is going on all the time, and even though small in itself, in the aggregate amounts to an important item. Further, this continued loss heats the insulation, and thus may become serious. The method which the author has devised consists in the application of a Wheatstone bridge in which the dielectric to be tested is placed in one arm. This behaves as an imperfect condenser, and it may be balanced by a perfect condenser placed in another arm of the bridge, if the latter be shunted by a proper non-inductive resistance. The author gives a mathematical analysis of this arrangement, using the complex resistance operators introduced by Heaviside. He shows that only in the case of a sine wave electromotive force is it possible to obtain a balance, unless the indicating instrument be one which responds to but one frequency, acting thus as a frequency filter. The instrument employed is the optical telephone devised by Wien. However, in the case of the existence of hysteresis, upper harmonics in the current should be taken into account.—*Abstracted from the Electrician (London), June 28.*

Some Newly Observed Manifestations of Forces in the Interior of an Electric Conductor.

It has been found that when a heavy electric current is passed through a fluid metallic conductor the liquid tends to become contracted in cross-section at the centre and to pile up at the ends, the depression occurring usually taking the form of the letter V. With exceedingly heavy currents this depression may reach the bottom of the conductor, causing a breaking of the circuit, when the liquid rushes together again, and the phenomenon is repeated. This effect has been studied in various ways by Dr. E. F. Northrup, who here describes his observations and gives an analytical study of the phenomena. A striking experiment consisted in using as the conductor a liquid alloy of potassium and sodium. This was placed in a trough with contracted centre and covered with kerosene. As the alloy has but a slightly greater specific gravity than the oil, a much smaller current was sufficient to produce very striking results. In one experiment a current of 180 amperes caused a depression of one and three-quarters inches. The author analyzes the forces acting within a conductor, and shows that the intensity of the field increases from zero at the axis to a maximum at the circumference. By means of a fine vanadium wire placed within a column of copper sulphate it was shown that when current was passed the wire was deflected toward the axis of the tube, thus showing a tendency for the conducting filaments to be drawn toward the centre. By passing a heavy current through a vertical column of mercury contracted at its centre, this force was found sufficient to cause the mercury to overflow at the top of the column. The effect was increased when the contraction of the column was caused by means of a slotted iron washer, which increased the intensity of the magnetic field at the point of contraction. The author then describes a method of constructing an apparatus by means of which this effect may be multiplied by connecting a number of such contractions in series. If the column of mercury be split up into layers by means of copper discs, through which holes are drilled obliquely from the centre to the edge, each of these will give rise to a force when a current is passed longitudinally through the column. The pressure thus developed is independent of the length of liquid strata, although the heat developed is directly proportional to this. The best effects are then obtained when the strata are thin. It has been found possible to employ this arrangement to construct current-indicating instruments, which are equally good for direct and alternating currents. In one such instrument, when the current was 600 amperes in the conductor, a pressure of 0.432 pound per square inch was set up, which is equivalent to the hydrostatic pressure of a column of water 11.9 inches high. The actual height attained by a column of water was nine inches, the difference being due to the fact that that of the mercury itself changes its level to produce the rise in water. With a heterogeneous conductor one-half inch in diameter, made up of 1,000 sections each one millimetre in length, 600 amperes should give rise to a pressure of 44.3 pounds per square inch, without any iron in the circuit.—*Abstracted from the Physical Review (Lancaster), June.*

The Vibration Galvanometer for Inductance Measurements.

At a meeting of the Physical Society, of London, held May 24, a paper on "The Measurement of Mutual Inductance by the Aid of a Vibration Galvanometer," was read by A. Campbell. Carey Foster's method of comparing a mutual inductance with a capacity is one of the most convenient methods, and the formula is very simple, being $M = KRr$, where K is the capacity (in farads) and R and r are resistances. The great advantage gained by the use of a vibration galvanometer in methods for measuring capacity or inductance led the author to apply it to the Carey Foster and the Hughes-Rayleigh methods. He found, however, that with alternating currents it was necessary to modify the Carey Foster method by adding a series resistance in the condenser branch; this left the formula $M = KRr$ unaltered and gave an additional formula involving the ratio of a mutual and a self-inductance. The modified method is extremely convenient, the two adjustments required for a balance being independent and the result not involving a knowledge of the frequency; the use of the vibration galvanometer is a great improvement, making the method independent of the wave-form of the current used. If the detecting instrument used in a null method (with alternating current) is adjusted so that its natural period is in tune with that of the applied voltage, it will be set into strong resonance and will be enormously increased in sensitivity for this particular frequency, practically ignoring in comparison all the other components of the wave-form.

The author exhibited a vibration galvanometer having a moving coil controlled by an adjustable bifilar suspension. By adjusting the tension of this the tuning is very easily effected. For measuring the frequency to which a tuned instrument is responding, it is convenient to use the Hughes-Rayleigh method, in which a known self-inductance is compared with an unknown mutual inductance, the balance being dependent on the frequency. The author showed such an arrangement in which the slide-wire was graduated directly in frequency. With accurately known frequency on the other hand, the method gives absolute values of L and M.

In conclusion the author gave results of tests (by several methods) of a standard mutual inductance of 0.05 henry. The Kirchhoff method with direct deflection on a ballistic galvanometer (of measured time of swing) gave a mean of 0.05014 henry, while the Carey Foster method gave 0.05009 henry; the probable error of the latter was much smaller than that of the older method.

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

The Sirius Colloid Lamp.

Something over eight years ago Dr. Hans Kuzel, of Vienna, set himself to the task of solving the problem which has absorbed the attention of so many men of science and technology, *i. e.*, the radical improvement of artificial production of light—particularly the electric light. Dr. Kuzel has demonstrated by many years of successful research and commercial application of the result of his research that he is a chemist of the highest ability. It was therefore a matter of more than ordinary importance when Dr. Kuzel withdrew from all other fields of activity and devoted himself to the thorough systematic and uninterrupted study of the possibility of incandescent electric lighting. He was already possessed of the idea that some of the rare metals possessing very high-melting points could be used most advantageously in suitable means for their preparation and the commercial production of filament from them could be found.

That his efforts have been richly rewarded is evident from the appearance of metallic filament lamps having a life of well over 1,000 hours at a consumption of one watt per horizontal candle-power, and whose filaments possess sufficient mechanical strength and flexibility to permit of their being used and handled with essentially the same facility as the ordinary carbon filament lamp, aside from the fact that as at present made they must be burned in a vertical or pendant position.

Dr. Kuzel has not claimed to be the inventor of a lamp containing a filament of a refractory metal, nor more specifically of a lamp with a tungsten filament, both of which have been known for many years. Dr. Kuzel's invention and the essence of his success is the use of metals in the colloidal state, by which he has been able to overcome the difficulties experienced by others.

The colloidal state is a peculiar condition into which metals may be thrown by various means and seems to be due to some peculiar arrangement of molecular complexes. The most characteristic property of colloid is plasticity. Thus clay differs from fine sand in that part of the material of the clay is colloidal, and therefore the clay is plastic. Another striking characteristic of colloids, particularly the colloids of metal, is that they are soluble in water. Colloidal gold will go into solution very readily and the solution can be evaporated to a paste or to dryness. Colloids have been recognized and studied by scientists for many years, but were never thought of seriously or supposed to have any commercial value until attention was strongly awakened through the publication of Dr. Kuzel's results something over a year ago. To-day there is in Germany a monthly publication devoted exclusively to colloids, both from the scientific and commercial standpoint, and the study of colloids promises to solve a great many important commercial problems, and to throw light upon many natural phenomena which has been hitherto quite obscure.

About a year and a half ago Dr. Kuzel's lamp was announced by Johann Kremenezky, in Vienna, and authoritative tests by the state laboratories of Austria were quoted showing a life of well over 1,000 hours at a consumption of one watt per candle. Since then an immense amount of work has been done in the direction of high-efficiency filament lamps, particularly tungsten. Many lamps have appeared on the market possessing more or less excellence. The difficulty uniformly experienced has been the extreme fragility of the filament, making it impossible to transport them in the ordinary manner. This, as well as all other serious difficulties, is overcome by the use of the colloidal process which, as already mentioned, is the basis of Dr. Kuzel's series of patents.

By the use of his process Dr. Kuzel is able to produce filaments of extremely small diameter and of perfect uniformity. In the process of preparing the colloidal metal it is possible to purify them to a degree not attainable by any other means. The filament which is formed by burning the metal in the colloidal state and then transforming it into the crystalline state, which is the state in which we ordinarily recognize metal, perfect homogeneity is obtained. This homogeneity seems to be of the very greatest importance and is used in the sense of chemical, electrical and mechanical homogeneity.

In Europe the Sirius lamps are now being made in Vienna by Johann Kremenczky, who controls the patent for Austria-Hungary, and who cooperated with Dr. Kuzel during the later stages of the development of the new lamp. Mr. Kremenczky is one of the most skilful lamp manufacturers in Europe and one of her best technicians. In Germany, Sirius lamps are made at Fürstenwald, at the lamp works of Gebrüder Pintsch, who are known the world over on account of the Pintsch gas-lighting system. In Nyköping, Sweden; a company is manufacturing lamps for Scandinavia and Denmark. It is expected that factories will be opened in other European countries in the near future.

At present lamps are made in candle-powers of twenty-five, fifty and 100, all operating at one watt per candle, and for voltages up to 130 volts. The standard candle-power is twenty-five, and these are made almost exclusively. Lamps have been sold for several months, delivery guaranteed, and very few claims for rebate or replacement have been made.

The Flexiphone—A New Telephone Instrument.

A new telephone instrument has recently been developed and placed upon the market by the Holtzer-Cabot Electric Company, of Brookline, Mass., in conjunction with the Oliver Manufacturing Company, of Philadelphia. This instrument, called the Flexiphone, takes the place of wall and desk telephones and is being adopted by a large number of telephone exchanges as the instrument which they recommend for office and house use.

In general, the Flexiphone is a combination of the best and most essential features of a desk telephone instrument and an adjustable telephone arm. It is self-balancing in any position, the tension of the springs in the arm being just sufficient to counterbalance the weight. This feature will be much appreciated as it leaves one hand free for making notes, etc.

The Flexiphone may be fastened to a flat or roll-top desk or to the wall, or mounted on a floor stand, and may be used equally well by persons of different heights, whether in a sitting or standing position. If desired, it may be arranged

to serve two desks. The telephone cords are secured to the arm and therefore never become twisted or kinked.

In detail, the salient points may be briefly outlined as follows, the pedestal and arm being treated separately:

The construction of the pedestal is unique and quite a departure from former

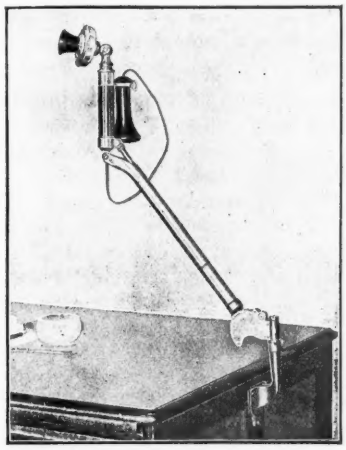


FIG. 1.—FLEXIPHONE IN POSITION.

types, the main feature being the accessibility of all the various parts and connections. By removing a small screw in the centre of the pedestal, the set can be readily taken apart and the outer casing removed, exposing the mechanism. The operating parts may be replaced in skeleton form without the casing, thus permitting a full view of the movement and al-

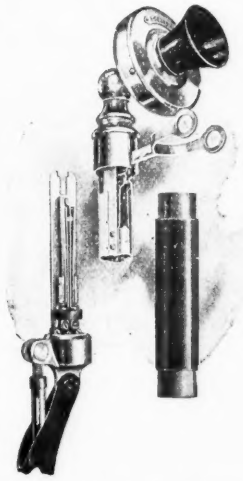


FIG. 2.—ASSEMBLY OF FLEXIPHONE.

lowing ready access for adjustment. All connections are brought out to terminals fitted into a hard rubber block which is securely fastened to the base of the pedestal frame. Hard rubber is used exclusively for insulating and pure platinum for all contact points. The contact springs are of German silver and rest against stops under tension. There are no unsoldered connections between the desk terminals and the transmitter, a point which will be instantly appreciated. The hook-switch acts directly upon the contact springs in the pedestal, thus doing away with all levers and lost motion. An auxiliary steel spring supports the weight of the hook, allowing the full elasticity of the contact springs to be used in making and breaking contacts.

The pedestal is made of heavy seamless tubing with an outer shell of hard rubber. It is mounted in such a way that it always remains vertical throughout all the move-

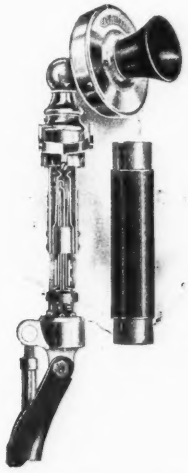


FIG. 3.—SKELETON VIEW OF FLEXIPHONE.

ments of the arm. The transmitter mouthpiece is secured at a convenient angle and the transmitter head is mounted on a swivel, which makes nearly a complete revolution in a horizontal plane. This, together with the vertical and swinging movement of the arm, gives practically any desired adjustment to the Flexiphone.

The instrument is wired for common battery, series or bridging magneto circuits, as desired. It is well adapted for home use, where the instrument is secured to the pedestal of the mantel.

The finish of the exposed metal surfaces of the pedestal and transmitter is polished nickel and the arm may be furnished either in a combination of nickel and hard rubber finish or in full nickel, as preferred.

1907 Types of Alternating-Current Lightning Arresters.

A new line of alternating-current lightning arresters has been developed during the last year by the General Electric Company, Schenectady, N. Y. These lightning arresters are designed to accomplish the following results:

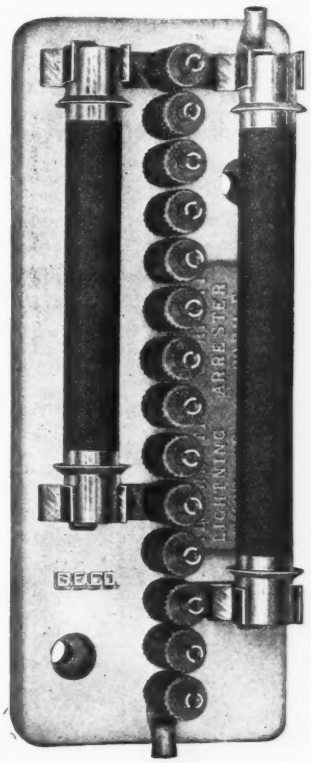
(1) Discharge potentials moderately higher than the potential of the circuit protected.

(2) Restrain the flow of the dynamic current across the gaps and extinguish the arc when normal potential is restored.

(3) Discharge high potentials covering a wide range of frequency.

(4) Prevent excessive rises of potentials between lines as well as between lines and ground.

These, like previous lightning arresters made by this company, are an elaboration



1907 TYPE ALTERNATING-CURRENT LIGHTNING ARRESTER.

of Prof. Elihu Thomson's fundamental patents, and investigations and experiments of the past year have suggested certain improvements. The lightning arrester consists in general of a number of spark-gaps, some of which are shunted by resistance rods. In this way, selective paths are formed and these are so designed as to give the arresters a uniform voltage breakdown regardless of the frequency or quantity of discharge.

The accompanying illustration shows a 2,300-volt, single-pole, station-type arrester. This form of unit is used in arresters up to 4,000 volts, and consists of a number of small knurled cylinders, portions of which are shunted by two resistances. One resistance rod of very low

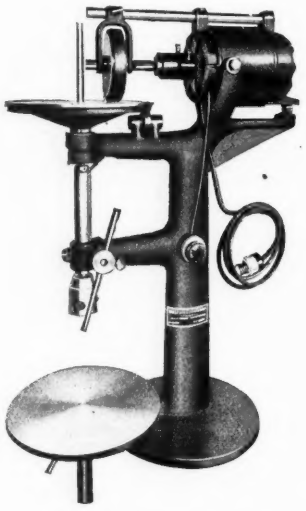
ohmic resistance shunts a small number of gaps, the second rod is of higher resistance and shunts a larger number of gaps. A disturbance of medium frequency will pass to ground through the low-resistance path, while low-frequency disturbances and steady static strains will discharge through the high resistance. Extremely high frequencies find a relatively difficult path through the resistance and a comparatively easy path of discharge across all of the gaps.

A New Portable Electric Drill.

A new portable electric bench-drill, made by the United States Electric Tool Company, Cincinnati, Ohio, is shown in the accompanying illustration. It is operated by direct current, which may be obtained through an attaching plug from an ordinary electric light socket, and is capable of drilling holes up to one-half inch in diameter in metal.

The friction disc-drive is arranged to compensate for wear automatically, the motor being pivotally suspended with a spring between the rear end of its frame and a bracket on the drill-press frame. The speed can be changed by moving the friction driving-wheel axially, the range of variation being from 390 to 950 revolutions per minute.

The total height of the drill is thirty-two inches and the weight complete, 112 pounds. The diameter of the table is twelve inches and the travel of the spindle six inches. The spindle has a vertical movement of ten and one-half inches, that being the maximum distance from the table to the lower end of the spindle.



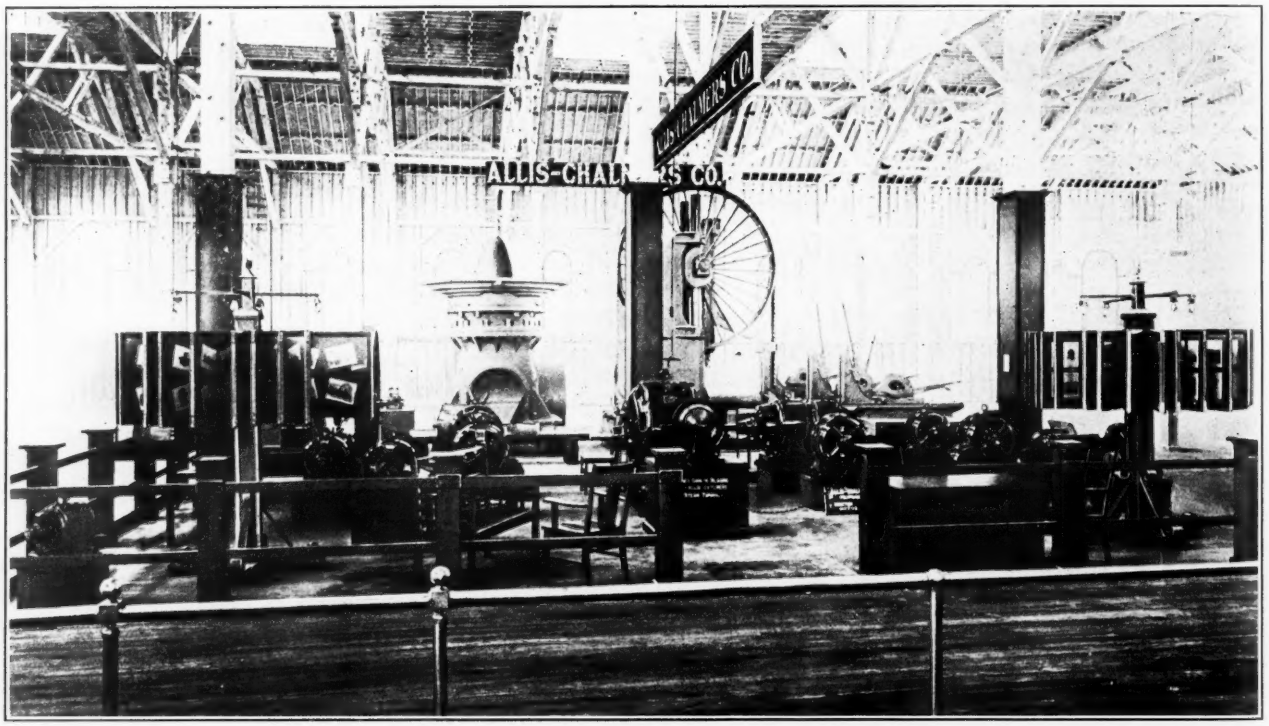
PORTABLE ELECTRIC DRILL.

The tool is especially adapted for small work.

The Allis-Chalmers Company at the Jamestown Exposition.

Among the exhibitors of machinery in the Machinery and Transportation Building at the Jamestown Exposition, Norfolk, Va., is the Allis-Chalmers Company, Milwaukee, Wis. This exhibit is not marked by the display of any unusual or special apparatus, nor does it include specimens of all the Allis-Chalmers Company's extremely large and varied line of products. The accompanying illustration gives a partial idea of the apparatus exhibited. The larger machines at the back of the picture are a No. 5 style K Gates breaker and an Allis-Chalmers band mill with sawmill carriage. The breaker is identical with those used by the Pennsylvania Railroad Company in the concrete construction of its tunnel under the East river, New York city.

The electrical machinery shown includes a belted alternator and an Allis-Chalmers "Reliance" engine. There is also a complete line of apparatus for electric drive, including induction motors and direct-current motors. There is a fine display of photographs, models and parts of the Allis-Chalmers steam turbines. A portable compressor outfit mounted on a truck, comprising a Christensen air-compressor driven by an Allis-Chalmers motor, together with the necessary accessories, is shown here.



PARTIAL VIEW OF ALLIS-CHALMERS EXHIBIT AT THE JAMESTOWN EXPOSITION, NORFOLK, VA.

The Leeds & Northrup Dial Decade Testing Set.

The instrument described and illustrated herewith is a new form of dial decade testing set and has several unique features in its design. It is arranged for the measurement of conductor and insulation resistance, the location of faults, crosses and grounds by the Murray and Varley loop methods, and the location of opens.

The arrangement of the bridge arms is a departure from the usual type of dial set in which it is customary to have a switch for each bridge arm, and consequently any resistances due to poor contacts enter directly to affect the accuracy of the ratio coils.

In this improved form of bridge, any resistances due to the switch contact can not affect the accuracy of the ratio coils, as will be evident from the connections for the bridge, since the contact of the switch S is in the battery circuit. The resistances a, b, c, d, e and f form the bridge arms; they are adjusted to a high degree of accuracy and are soldered to the contact studs as shown. Their values are such that when the switch S is placed at 0.01, 0.1, 1, 10, 100, the ratio $\frac{A}{B}$ will be that indicated for any particular setting. The switch S, therefore, serves as the junction point of the arms A and B of the bridge.

This method of connecting the coils in the bridge arms also simplifies the manipulation of the bridge, since it is only necessary to multiply the rheostat setting for a particular balance by the setting of the bridge-arm switch used in the same measurement. If the bridge-arm switch is on the contact marked 0.1, then the unknown resistance is 1-10 of the rheostat setting; if the ratio 1 is used, then the unknown resistance is read in direct terms of the rheostat, or, if the ratio is 10, then the unknown resistance is 10 times the rheostat setting, and so on. It will thus be noted that the complication of memorizing certain plug settings in order to produce the ratios $\frac{A}{B}$ or $\frac{B}{A}$, as is the case in plug bridges employing a commutator in the bridge arms, is hereby avoided.

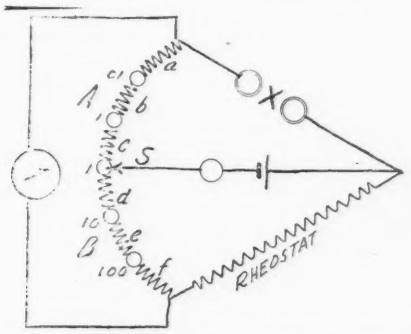
The rheostat coils consist of ten units, nine tens, nine hundreds, and nine thousands, making a total of 10,000 ohms. The switches have been designed so as to insure good contact. Each dial has its switch made up of six brushes making independent contact and with the ends of the brushes bent so that they do not lie tangent to the circle in which they travel, and consequently do not wear grooves or rings in the surfaces of the contact studs. It will also be noted that the switches may be rotated continuously in either direction, thus moving from the highest point in any particular group of coils to the lowest without the necessity of turning back through all the other coils. This arrangement is very desirable when locating swinging crosses, since the bridge can be balanced with rapidity. The inner ring of each switch provides a continuous bearing surface, so that any dependence upon friction in the central bushing for contact is avoided.

It will be noted that the parts have been grouped so as to provide for maximum convenience of manipulation. The switch heads stamped 1, 10, 100 and 1,000 form the rheostat, and the switch in the upper left-hand corner is the bridge-arm switch. The small single-pole, double-throw switches serve to arrange the bridge connections for resistance or loop testing and can be set for a particular test by reference to the stamping on the switch ends without the necessity of referring to a diagram of connections.

The galvanometer is of the D'Arsonval type, and is not at all influenced by surrounding magnetic fields. It has been designed to withstand the rough usage to which portable testing sets are at times subjected.

An Ayrton shunt is provided so that the galvanometer deflections may be reduced in proportions of 0.1 and 0.01.

NEW DIAL DECADE PORTABLE TESTING SET.



CONNECTIONS, DIAL DECADE TESTING SET.

The BA and GA keys are of the lock-down type—although not shown as such in the illustration—which permits these circuits to be permanently closed when locating opens. The operator thus has the free use of his two hands for manipulating the set.

The binding posts stamped GA and BA are provided so that a sensitive reflecting galvanometer or more battery may be used when locating high resistance faults, but for all ordinary purposes, the contained galvanometer is amply sensitive and the contained battery has sufficient electromotive force.

The resistances are wound with manganin. By a special method of adjusting, which the manufacturers have employed, it is possible for the user of the bridge to replace a burned-out coil without altering the accuracy of adjustment of the other resistances in the instrument.

The instrument is made by the Leeds & Northrup Company, 4901 Stenton avenue, Philadelphia, Pa.

Current Electrical News

DOMESTIC AND EXPORT.

UNITED ELECTRIC COMPANY LEASE APPROVED—At a meeting of the stockholders of the United Electric Company of New Jersey, held at Newark, N. J., July 12, the lease of the property and franchises of the company to the Public Service Corporation for a term of 999 years was approved. Out of 200,000 shares of stock, 196,731 shares were voted in favor of the lease and 888 shares against it.

BIG COLORADO POWER PLANT STARTED UP—The Northern Colorado Power Company has its big plant at Lafayette finished. The work of transmitting power will be begun next week. Light and power will be supplied to all northern Colorado towns. Longmont will be the first town on the 40,000-volt power line to be supplied with power. The voltage on the line to Boulder will not be higher than 13,500 volts. After Longmont is supplied, the 40,000-volt line will be opened to Berthoud, Loveland, Fort Collins and the other towns.

JERSEY CITY ENJOINED FROM BLOCKING HUDSON TUNNEL—Vice-Chancellor Bergen has granted an injunction restraining the mayor and aldermen of Jersey City, N. J., from interfering with the work of the Hudson & Manhattan Railroad Company in constructing its tunnel under Railroad avenue in that city. In the work of construction under Railroad avenue, where connection is to be made with the Fennsylvania Railroad, it is necessary to change the sewer and water pipes, and it is this that the mayor of Jersey City has sought to prevent. In the bill filed it is charged that the police interfered with the workmen of the company.

OHIO TRACTION MERGER PLANNED—Preliminary negotiations are said to be under way for the consolidation of the interurban traction lines entering Cincinnati, Ohio, not controlled by the Widener-Elkins syndicate through the Schoepf interests. The independent lines include the Interurban Railway Company, the Cincinnati & Columbus Traction Company, the Cincinnati, Milford & Loveland Traction Company and the Cincinnati, Georgetown & Portsmouth Traction Company, operating about 250 miles of road. The backers of the proposed consolidation are said to be eastern capitalists allied closely with the Columbus Gas and Electric Company. It is rumored the new company will have a capital of $10,000,000.

MEXICAN ELECTRICAL NOTES—Engineers of Torreon, Mexico, are engaged in laying out the route of the new street-car line that is to be built between Torreon and San Pedro, Coahuila, a distance of about twenty-five miles. The route will traverse the most valuable farming lands in the Laguna district. The concession for this electric line was given to the mayor of San Pedro, and several wealthy citizens of that city and neighboring cities have organized a company and will carry the project through. The Chinese people, who are building an electric line in the city, are pushing their work as fast as possible, having already commenced grading, and the construction work, it is thought, will begin in the very near future. The street-car line that is in operation in this city at present is equal to any in operation in the Republic, and besides the local circuit, the same company operates a fifteen-minute schedule between Torreon, Gomez Palacio and Lerdo, and from Torreon to the smelter a fifteen-minute schedule is also in operation.

CHICAGO TRACTION—Judge Grosscup has signed a certificate making absolute and permanent the deposit of Chicago Union Traction and underlying securities and settling the question that he and Professor Gray as arbitrators have power to decide on the equity of distribution of all the assets. Judge Grosscup says that the objections filed by the West Chicago Street Railway stockholders will not prejudice the case. According to a Wall Street news agency, the financial plan of the Chicago Railways Company, which is to take over the North and West Side Traction properties in that city, contemplates the issuance of an unnamed amount of first mortgage bonds to cover the cost of rehabilitation. They are to be twenty-five-year issues bearing five per cent. Second mortgage consolidated bonds, sinking fund debentures and collateral notes aggregating $47,300,000. Income participation certificates bearing eight per cent, if there is that much left for the new receipts, to cover the stock issue, aggregating $23,250,000. The Union Traction stock, totaling $32,000,000, is cut in two, with respect to the common issue of $20,000,000. Underlying interests are well provided for, with the exception of the so-called Yerkes securities, in the second underlying organization.

CANADIAN GENERAL ELECTRIC COMPANY INCREASES CAPITAL STOCK—Directors of the Canadian General Electric Company have decided to ask the shareholders of the company to ratify a by-law providing for an increase of the company's capital stock from $5,000,000 to $8,000,000. Of this increase $2,000,000 will be seven per cent cumulative preferred stock, and $1,000,000 common stock. It is not, however, the intention to issue the common stock at present, but to hold it in reserve as treasury stock. The explanation is made that the directors deem it advisable to issue preferred, instead of common stock, "as the saving in interest will increase the net profits available for the holders of common stock, and the issue can be readily sold in England, should the shareholders not desire to take the whole of the same." The circular goes on to explain that the moneys received from the issue of $2,000,000 preferred stock will be applied to redeem the present issue of $300,000 preferred stock, to redeem the $160,000 bonds of the Northey Steam Pump Company, which are guaranteed by the Canadian General Electric Company, and will leave the entire assets of the Northey company free from mortgage or bonded indebtedness of any description, while the balance will be applied in the repayment of advances made by the company's bankers. The new preferred stock is to pay seven per cent in dividends. The old preferred stock, which is to be retired, paid six per cent.

MORE POWER FROM THE SAVANNAH RIVER—H. A. Orr, of Anderson, Ga., president of the Savannah River Power Company, which has a capital stock of $8,500,000, has announced that the Calhoun Falls property would be developed this summer. These falls will furnish 30,000 horse-power. He also announced that Cherokee Falls, which is ten miles below Gregg shoals on the Savannah river will be developed this summer. These falls will furnish 10,000 horse-power. He further stated that Hatton's shoals on the Tugaloo river will be developed this summer and that these falls will furnish 10,000 horse-power. All of this power is in connection with the 5,000 horse-power to be developed on Broad river, in Georgia, at Anthony Falls, near Elberton, and 3,000 horse-power at Gregg shoals on the Savannah river will aggregate 58,000 horse-power for this concern. Mr. Orr says that Major E. W. Lewis, of Wilmington, N. C., who is associated with the company, and Colonel Springfield, of New York, two expert engineers, are now visiting Calhoun Falls to make an inspection of the property of the company. There are two falls there, surveys of which have been made. These gentlemen are to determine whether one or two dams shall be constructed in this development. In either event the falls will furnish 30,000 horse-power. President Orr was asked whether the company anticipated any trouble in disposing of all of this power. He replied: "It is not a question of selling the power that we can furnish out of all these developments. It is a question of choosing our purchasers. We are almost daily receiving applications for power. We will be able to place all of the power we can develop." The following are stockholders in the Savannah River Power Company (consolidated): C. Elmer Smith, York, Pa.; Eugene B. Ashley, Glens Falls, N. Y.; A. T. Smythe, Charleston; B. Calhoun, San Francisco; Westinghouse, Church, Kerr & Company, New York; Electric Properties Company, New York; Major E. W. Lucas, Wilmington, N. C.; Mr. Springfield, New York; J. E. Sirrine, Greenville; Dr. S. M. Orr, Anderson; H. A. Orr, Anderson, and Colonel H. H. Watkins, Anderson.

ELECTRIC RAILWAYS.

UTICA, N. Y.—Work has been commenced by the Utica & Mohawk Valley Railway Company on the electrification of its Deerfield line.

ROME, N. Y.—Plans are being prepared by the Utica & Mohawk Valley Railway Company for a new depot at Rome to take the place of the one now in use.

QUINCY, ILL.—Twenty-five of the leading business men have organized themselves into a stock company, with a capital of $25,000, to pay the preliminary expenses of interurban lines to Hamilton, Ill., and south from here to Pearl, Pike county, to be financed by local capital.

HARTFORD, CT.—The Connecticut Senate and House have passed a bill incorporating the Bridgeport & Danbury Electric Railway, and fixing the maximum of capital stock at $1,500,000. The incorporators of the road are: William H. Marigold, John T. King and Henry E. Reilly, all of Bridgeport.

WAYCROSS, GA.—The franchise recently granted by the city council of Waycross to Burdette Loomis, of Hartford, Ct.; George W. Deen, of Waycross, and F. H. Elmore, of Jacksonville, Fla., to construct and operate an electric railway and gas plant in Waycross, has been accepted by the company.

FORT WORTH, TEX.—It develops that a private concern, headed by Major Beardsley, will build the Fort Worth-Mineral Wells interurban and when completed turn the property over to Stone & Webster. It is also asserted that Stone & Webster will furnish any financial backing that may be required.

BALTIMORE, MD.—A single-track electric line, one and one-half miles long, to extend from the terminus of the United Railways and Electric Company's line at Dickeyville to Lorraine Cemetery, is being built by the Lorraine Electric Railway Company. The latter has a capital stock of only $25,000, and is controlled by the interests that manage the cemetery company.

BRISTOL, VA.—Work on the new street-car system in Bristol has been begun. The line must be in operation between State street and a point opposite Virginia Institute, to validate the franchise, within six months. The Bristol Belt Line Railway Company, which has the franchise, says that the line will be completed and in operation within sixty to ninety days.

SPOKANE, WASH.—The corporation which owns and operates the system of electric roads known as the "Inland Empire System" now has the prefix "Spokane" to its official name and title. The holding corporation, owning the stock of four separate companies, as they were originally formed and constituting the Graves lines, now bears the name of the "Spokane & Inland Empire Railway Company."

BOONE, IOWA—At the annual meeting of the Boone, Webster City & Interurban Company, the following directors were elected: E. E. Hughes, M. J. Reilly, F. A. Sackett, Webster City; John L. Goeppinger, J. H. Herman, T. L. Jones, J. S. Crooks. The directors then met and elected the following officers: president, E. E. Hughes; first vice-president, F. A. Sackett, Webster City; second vice-president, John L. Goeppinger; treasurer, J. H. Herman; secretary, J. S. Crooks.

SPOKANE, WASH.—The engineers of the Cascade Valley Railroad Company, under L. M. Rice, of Seattle, are now working on the final location of the projected electric line from Rockport through the Cascade pass, and its president and promoter, W. A. C. Rouse, says that work on actual construction will begin within the next sixty or ninety days. Right of way is now being secured, and the final location has been made as far as Marblemount, a distance of ten miles beyond Rockport.

OMAHA, NEB.—Arrangements have been made for the completion of the Omaha, Lincoln & Beatrice Railway Company, and work is expected to be taken up where it ceased with President Robinson's death, and pushed to completion. Cleveland and Chicago money has been taken into the company and funds are now available for laying track and equipping the line between Omaha and Lincoln. Part of this line is finished at both ends, but there is a long gap in the middle to be completed.

ALBANY, N. Y.—The directors of the United Traction Company have organized by re-electing the following officers for the ensuing year: president, L. F. Loree; vice-president, C. S. Sims; secretary and treasurer, James McCredie; acting auditor, D. C. Dibell; general manager, Edgar S. Fassett. The same officers were elected for the Waterford & Cohoes Railway, the only change in the board in this case being the election as a director of Edgar S. Fassett. The company has filed with the secretary of state four certificates of extensions to its lines.

GAINESVILLE, TEX.—E. W. Wichey, representing Chicago capitalists, has secured a renewal of the franchise granted some time ago for the Gainesville-Whitesboro-Sherman Interurban Electric Railroad. Mr. Wichey stated that the people he represents are in earnest and that he was prepared to obligate himself that the road will be in operation by July 1, 1908. On this showing the council renewed the franchise for one year from July 1, 1907. The bonus of $250,000 required of local people has been subscribed and will be paid over at the proper time.

MENOMONIE, WIS.—The Chippewa Valley Electric Railroad Company is expending more than $200,000 in a new water power plant in this city, which will furnish power for operating all its lines of street railway. This company owns the water power on the Red Cedar river at Menomonie, Cedar Falls and Downsville, aggregating 10,000 horse-power and the work now in progress at Menomonie is the beginning of a water power development which will cost more than half a million dollars. The new water-wheels being installed are the largest ever used in northern Wisconsin.

MERIDEN, CT.—At a meeting of the stockholders of the Torrington & Winchester Street Railway and the Meriden, Southington & Compounce Tramway Company these two concerns were formally merged with the New Haven road. The Torrington road has twelve miles of rail. This is located in the towns of Winchester, Torrington and Winsted. It also operates a line to Highland Lake, an up-state summer resort. The Meriden & Southington line also operates about twelve miles of track. Both these companies were held by interests identified with the Connecticut Railway and Lighting Company.

WARREN, OHIO—The receiver of the Eastern Ohio Traction Company, operating several lines of tracks, offered the property for sale in Cleveland on June 25, first as a whole and then by divisions. Bidders were few. The Garrettsville division was bid in by H. P. McIntosh, of Cleveland, in the interests of the Eastern Ohio Traction Company, general mortgage bondholder, for the upset figure of $152,500. No bids were received for the eastern division between Cleveland and Chardon and the Chagrin Falls division from Cleveland to Chagrin Falls. It is likely that these divisions will be re-appraised and again offered for sale.

COUNCIL BLUFFS, IOWA—A proposed interurban railway across Iowa from Muscatine to Council Bluffs is the latest development in the Iowa interurban situation. Dispatches announcing the plan come from Des Moines, which is one of the places to be touched by the proposed line. The road will also run through Sigourney, Oskaloosa, Knoxville, Indianola, Winterset, Greenfield, Fontanelle, Griswold and Carson. From Carson it is planned to enter this city. Reports state that right of way and franchises have already been secured for a large portion of the distance and that construction work will be started from Des Moines in from sixty to ninety days. The work is in charge of the American Electric Railway Company, an Iowa corporation, which is said to be the representative of a Chicago bonding company. Money has been donated to the sum of $100,000 by several towns along the route. More money is not being sought, however, as capital will be furnished by the Chicago financiers. The equipment for the road, says C. W. Baker, the Des Moines agent of the company, has been ordered and rails and steel cars will be ready within a few months. Contractors are now preparing for the construction work. It is intended to make the Iowa line part of a great system of interurban railways which will cross the country from east to west. As soon as the new line is built, it is declared, connection will be made with Illinois lines. For some time, however, no connection will be made with Nebraska lines.

PERSONAL MENTION.

MR. THEODORE N. VAIL has been elected president of the New York Telephone Company, to succeed the late Charles F. Cutler.

MR. B. F. HEMENWAY has been appointed manager of the Montpelier (Vt.) exchange of the New England Telephone and Telegraph Company.

MR. ROBERT WALTERS, of Kalamazoo, Mich., has been appointed director of construction in connection with the power plant which the state of Michigan will erect at Jackson.

MR. W. J. BARR, president of the W. J. Barr Electric Manufacturing Company, Cleveland, Ohio, manufacturer of the Eureka electric heating apparatus, was a visitor to New York last week.

MR. HARRY NEEDHAM, who has been connected with the Richmond Light, Heat and Power Company, Richmond, Ind., has been made manager of the Franklin Water, Light and Power Company, of Franklin, Ind.

MR. RAYMOND H. SMITH, who has been appointed general manager of the Albany & Hudson Electric Railway and Lighting Company, has been presented with a diamond stud by his former employés on the Bridgeport division of the Connecticut Railway and Lighting Company, of which he was superintendent.

MR. NEIL S. BROWN has resigned as chief operator of the Nashville (Tenn.) office of the Western Union Telegraph Company, due to ill-health. He was presented with a handsome watch by his associates. Mr. Brown has been in the service of the Western Union for thirty-seven years, having worked his way up from the position of messenger boy.

MR. JAMES F. LAND, general manager of the Michigan State Telephone Company, has tendered the company's board of directors his resignation as head of the concern, which he has served for twenty-nine years. He will devote his time to advancing the welfare of the company formed to handle the "Televent," a device to enable people to listen in their own homes to theatrical performances, concerts and lectures.

MR. J. C. McQUISTON, manager of the Westinghouse Companies' Publishing Department, is the author of a fine article entitled "Good Advice to Trade Papers," in the July issue of *Profitable Advertising*. Mr. McQuiston presents in this article a number of common-sense views in a most instructive and illuminating manner. The presentation will not fail to increase the already universal popularity of this bright young Pittsburger.

MR. R. P. STEVENS has been elected president of the Lehigh Valley Transit Company, which operates 142 miles of electric railways in Chestnut Hill, Allentown, Bethlehem and other points in the Lehigh Valley, Pa. Mr. Stevens is now general superintendent of the Auburn & Syracuse Railroad. He is a graduate of the University of Maine and the Massachusetts Institute of Technology. In 1900 he reconstructed the Everett Railway and Electric Company, of Everett, Wash. While in the West he built an interurban line and electrified the lines of the Northern Pacific from Everett to Snohomish. He went to Auburn, N. Y., two years ago.

MR. IRA A. McCORMACK has resigned as assistant to the general manager of the New York Central lines, to become president and general manager of the Randolph & Cumberland Railroad, and of an extensive development company, planned to exploit the road's resources. The resignation takes effect at once. Mr. McCormack has had charge of the New York city terminal operation of the Central and was previously connected as general superintendent with the Brooklyn Rapid Transit Company and the Cleveland Electric Railway Company. The road which he is to head extends from Cameron to Hillsons, in North Carolina, and is to be extended to a total length of 216 miles.

MR. GUY W. TALBOT, vice-president and general manager of the Corvallis & Eastern Railroad, lately acquired by the Harriman interests, has resigned to become vice-president and general manager of the Oregon Electric Railway. His connection with the Corvallis & Eastern will end as soon as his successor is chosen, when he will devote his entire time to the management of the Salem electric line, now nearing completion. He began his railroad career with the Burlington at Des Moines, Iowa, and was later connected with the Des Moines Northern & Western, the Des Moines Union & Terminal Company, the Iowa Central and the Peoria & Pekin Terminal Railway. He went from the general managership of this last property to Portland, Ore.

MR. WILLIAM J. WILGUS, chief engineer of the New York Central & Hudson River Railroad Company since 1903, will sever his connection with the road on October 1. Mr. Wilgus has been in charge of the electrification of the road and the terminal improvements at the Grand Central Station. For some time he has desired to be relieved of the burdens of this position, but the work was of such great importance and so entirely in his hands that it was not possible for the company to relieve him. Mr. Wilgus is a graduate of a Buffalo, N. Y., school of engineering, and entered the railroad field as a rodman and draftsman in 1885 at St. Paul, Minn. He held several important posts with the Hill roads, and his connection with the Vanderbilt lines dates from 1893, when he became assistant engineer on the Rome, Watertown & Ogdensburg Railroad.

TELEPHONE AND TELEGRAPH.

BRISTOL, N. H.—The Home Automatic Telephone Company is expected to commence work in this city shortly. It now has conduit gangs at work in New Haven, Fall River and New Bedford, and it is the intention to send them here as soon as the work in those places is finished.

DENVER, COL.—Justice Gabbert, sitting in the Supreme Court, has decided that the franchise granted the Automatic Telephone Company is invalid. It is held that the election at which the franchise was secured was held in November, when the matter should have been submitted at a spring election.

WASHINGTON, ME.—The Washington Telephone Company has been incorporated with a capital stock of $1,000, of which $150 is paid in. The officers are: president, Charles Lynch; vice-president, B. K. Ware; general manager, W. F. Hatch; treasurer, W. E. Overlock; directors, W. O. Luce and W. W. Light.

AMARILLO, TEX.—The voters of Amarillo have declared in favor of granting a franchise for an independent telephone system. The franchise is to be awarded to H. H. Davenport & Company, of Hillsboro. It is to run for a term of thirty years, and binds the company to install a modern system, costing approximately $100,000.

PROVIDENCE, R. I.—The Providence Telephone Company has abandoned its old West Exchange quarters in the Library Building on Olneyville Square and "cut over" its thousands of connections into the big and up-to-date common battery switchboard in the new telephone building on Bough street. The new board has a capacity of 9,000 lines.

MONTPELIER, VT.—The Southern Vermont Telephone Company has filed with the secretary of state articles of association and will build, maintain and operate such telephones and lines as shall become necessary for public use in the counties of Windsor, Windham and Bennington. The capital stock is $5,000 and is divided into 500 shares. The subscribers are Forrest A. Richmond, of Woodstock; Winfred A. Perkins, of Bethel; H. P. Clark, of Woodstock; Francis C. Whitman, of Boston; L. Glenn Lyman, of Hartford, and Harry W. Hoye, of Woodstock.

CHIHUAHUA, MEXICO—The Mountain Mining and Valley Telephone Company, which is building a telephone line from El Paso to connect with the towns and camps in the western part of Chihuahua and eastern Sonora, has completed the line from Nueva Casas Grandes to the Mormon colony of Chuicupa and from that point to Guaynopa. It is probable that the line from Guaynopa will be extended to Medera, the new town of the Sierra Madre Land and Lumber Company. Local systems will be installed at Nueva Casas Grandes, Dublan, and other towns. The company hopes to have the line into El Paso by the first of the coming year.

OBITUARY NOTES.

MR. R. F. GOTTSCHALK, president of the Columbus (Ind.) Street Railway and Light Company for fifteen years, was killed on July 11 by accidentally touching an electric wire.

MR. JOHN H. PERKINS, Riverhead, Long Island, for several years county superintendent for the New York & New Jersey Telephone Company, died at his home on July 11, aged forty-five years. Death was due to paralysis.

EDUCATIONAL NOTES.

POLYTECHNIC INSTITUTE OF BROOKLYN—The fifty-second annual catalogue of the College of Arts and Engineering of the Polytechnic Institute of Brooklyn has been issued. This describes the aims of the institute and the courses offered there, and gives a list of the faculty and students.

CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY—The Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., has issued in pamphlet form a reprint of the commencement address delivered on June 14 by John F. Hayford. The subject on which Mr. Hayford spoke was "Study Men." It calls attention to the importance to the young engineer of studying those with whom he is thrown in contact, as well as the apparatus with which he has to deal.

NEW MANUFACTURING COMPANIES.

AUSTIN, TEX.—The Electric Construction Company has been incorporated with a capital of $20,000. Its headquarters will be at Dallas. The incorporators are: W. M. Brooks, Wallace J. Stroud and J. Lee Norman.

TRENTON, N. J.—The Rumsey Electric Company has been incorporated with a capital of $125,000, to deal in electrical appliances. The incorporators are George A. Rumsey, Sr., W. T. Thomas and Clarence S. Butler.

CAMDEN, N. J.—The Bennett Electric Manufacturing Company has been incorporated to manufacture, buy and sell and lease prismatic hoods and chandeliers. The capital of the company is $100,000, and the incorporators are F. M. Bennett, W. R. McDonald and Ivan R. Shull.

SAN DIEGO, CAL.—The Loomis, Shaffer & Moses Electric Company has filed articles of incorporation. The purpose of the company is to carry on a general electrical business, to erect buildings and equip same with electrical and other appliances, to buy and sell goods of all descriptions, to deal in real estate, to borrow money and secure the payment thereof by mortgaging its property, and to make contracts for equipping buildings with electrical wiring, machinery, apparatus and power. San Diego is named as the principal place of business, and the period of incorporation is for fifty years. The directors are three in number as follows: Harry L. Loomis, E. E. Shaffer, Jr., and Rufus P. Moses, all of San Diego. The capital stock is $10,000, divided into 10,000 shares of the par value of $1 each. The amount actually subscribed is $5,000.

NEW INCORPORATIONS.

CHICAGO, ILL.—Midland Telegraph Company. To operate telephone and telegraph lines. $10,000. Incorporators: Nathan S. Smyser, John A. McKeown and I. W. Raymond.

SPRINGFIELD, ILL.—Arthur Mutual Telephone and Telegraph Company. To operate a telephone and telegraph line. $20,000. Incorporators: Marion Watson, H. Jenne, J. B. Craig.

DENVER, COL.—Cañon City, Pueblo, La Junta Railway and Power Company. $200,000. Incorporators: Charles R. Buckey, Thomas J. Stanley, Andrew J. Behymer, Perry Behymer, Daniel W. Sheldon, George D. Kendall, Francis James, Pueblo.

QUINCY, ILL.—St. Louis, Terre Haute & Quincy Traction Company. To build a line with its starting point on the state line between Illinois and Indiana opposite the city of Terre Haute, Ind., then to Venice and Quincy, passing through the counties of Adams, Pike, Scott, Green, Macoupin, Sangamon, Shelby, Coles, Cumberland, Clark, Fayette, Bond and Madison, with a bridge spanning the Illinois river at a point between Bedford and Florence, Pike county, and a point to be determined in Scott county. $25,000. Incorporators: Edward Yates, of Pittsfield; Peter Chase, of Decatur; C. W. Payne, of Roodhouse; H. C. Simons, of Virden; E. E. Barclay, of Springfield, and H. T. Wilson, of Virden; board of directors: P. Chase, E. E. Barclay, Edward Yates, C. W. Payne and H. C. Simons.

ELECTRICAL SECURITIES.

Although trading in the stock market during the first part of the week showed some improvement, there was a considerable decline in prices toward the end and a return to dullness. No severe break however, is looked for, the adverse monetary situation being held responsible for the above conditions. The break in the price of copper, and the decision of Judge Holt, overthrowing the demurrer filed by the Belmont-Ryan syndicate in the Interborough-Metropolitan suit, had a somewhat depressing influence. The Interstate Commerce Commission's report on the Harriman situation, however, was somewhat less severe than had been anticipated. The July government crop report, showing the situation as of July 1, proved favorable, and due to the continued propitious weather, the indications are that a still better showing may be looked for.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JULY 13.

New York:	*Closing.*
Allis-Chalmers common	10⅞
Allis-Chalmers preferred	29⅜
Brooklyn Rapid Transit	58¾
Consolidated Gas	118½
General Electric	136
Interborough-Metropolitan common	16
Interborough-Metropolitan preferred	44½
Kings County Electric	120
Mackay Companies (Postal Telegraph and Cables) common	66½
Mackay Companies (Postal Telegraph and Cables) preferred	65
Manhattan Elevated	130
Metropolitan Street Railway	85
New York & New Jersey Telephone	100
Western Union	77½
Westinghouse Manufacturing Company	143

Kuhn, Loeb & Company announce that all of the $6,000,000 Westinghouse Electric and Manufacturing Company three-year 6 per cent collateral notes purchased by them have been sold. In a circular to stockholders accompanying dividend checks George Westinghouse, president of the Westinghouse Electric and Manufacturing Company, announces that of the 100,000 shares of new stock recently offered to stockholders between 33,000 and 35,000 shares were subscribed for and payment made. Secretary Chas. A. Terry, of the Westinghouse Electric and Manufacturing Company, when asked if he had any comment to make concerning an article in the New York *Sun*, replied that legal requirements make necessary a formal offering to stockholders of the company of any new shares to be issued and, as is usual in such offerings, the directors of the company have authorized its treasurer to sell from time to time, at the price offered to shareholders of $75 per $50-share, any of the shares not subscribed for under the offering recently made. It is not the intention of the company to make a formal extension to the shareholders because such an extension is not necessary. The officials of the company, considering the general conditions prevailing, regard subscriptions for 33,000 shares out of 100,000 as satisfactory, and the proceeds, coupled with other resources of the company, sufficient to meet its needs. The company is making the largest sales in its history on a cash basis with a manufacturing profit approximately twenty per cent on its shipments. With the sale of 33,000 shares, it will, when needed, have available $5,000,000 of its convertible sinking fund bonds to meet the requirements of a greatly enlarged business.

The consolidated income account of New York City Railway and allied companies for the nine months ended March 31, 1907, shows surplus of $459,827 applicable to the 7 per cent dividend on Metropolitan Street Railway stock, after interest, taxes (not including special franchise tax in litigation), etc.

Boston:	*Closing.*
American Telephone and Telegraph	106¾
Edison Electric Illuminating	212
Massachusetts Electric	56½
New England Telephone	110
Western Telephone and Telegraph preferred	70

Philadelphia:	*Closing.*
Electric Company of America	9⅜
Electric Storage Battery common	51
Electric Storage Battery preferred	51
Philadelphia Electric	8⅛
Philadelphia Rapid Transit	23
United Gas Improvement	91½

Chicago:	*Closing.*
Chicago Telephone	122½
Chicago Edison Light	144½
Metropolitan Elevated preferred	64
National Carbon common	71
National Carbon preferred	114
Union Traction common	—
Union Traction preferred	—

ELECTRIC LIGHTING.

BUFFALO, N. Y.—E. J. Atherton is organizing a stock company in Angelica to build an electric lighting plant there.

CANAL DOVER, OHIO—The Orrville Light, Heat and Power Company, owned by local people, has been sold to D. I. Rennecker, of Sherodsville. The consideration was $15,000.

MIDLAND, MICH.—The Tittabawasse Power Company has filed with the county clerk a certificate of increase of capital stock of $1,250,000. Of this amount $250,000 is preferred stock.

SPARTA, TENN.—The election, submitting to the voters the proposition to issue bonds in the sum of $40,000 to put in a municipal electric light and waterworks plant, resulted in a decision against the project.

LAWTON, OKLA.—The sale has been completed whereby a controlling interest in the Lawton electric plant has been purchased by D. L. Larsh and S. P. Render, of Norman, and the new owners have taken charge. Fred Bedford will continue to manage the plant. Extensive improvements will be made.

BALTIMORE, MD.—The retiring directors of the Consolidated Gas, Electric Light and Power Company have been reelected and Thomas J. Shryock was chosen to fill a vacancy on the board. The annual report shows net income above operating expenses of $1,711,000, fixed charges of $1,081,000 and net earnings of $630,000.

BROWNSVILLE, TEX.—Brownsville is to have a modern electric light plant and waterworks, not to exceed $70,000 in cost. At a meeting of the city council, W. P. Bullock, of Kansas City, was appointed engineer to draft plans for same, and a special election was called to vote on a bond issue of $70,000 to pay for the construction of the plants.

ALBANY, N. Y.—Consent has been given the Canton Electric Light and Power Company to increase its capital stock from $18,000 to $38,000. The increase applied for was $50,000. The application of the Suffolk County Lighting Company for a certificate of authority to transact business in the town and village of Babylon, Long Island, has been granted.

BALTIMORE, MD.—Mayor Mahool has given orders for the abandonment of the municipal lighting plant. The plant, used only to illuminate the city hall and court house, cost the city $30,000 a year. The Maryland Electric Company has offered to furnish the light for these two buildings and for the city hall annex besides for $7,500 a year. The city formerly furnished the illumination for the various parks, but this was abandoned several years ago, private corporations having offered to do it more cheaply.

WACO, TEX.—A plan has been put on foot here for generating electricity at the Lignite coal mines, sixty miles south of here in Milam and Robertson counties, and transmitting the current to Waco and other cities and towns as far south as Houston for light and power. Joseph J. Henry and others, of New York, have been granted fifty-year franchises by this city and valuable concessions by other towns and cities within a large radius in consideration of securing electricity at a reduction of at least forty per cent.

ALBANY, N. Y.—A certificate of authority has been granted to the Sayre Electric Company, a foreign corporation, operating in Sayre, Pa., to transact business in Waverly, Tioga county, N. Y., and also to lease the distributing system of the Waverly Electric Light and Power Company for a term of ninety-nine years. The order was granted on condition that the lease be amended to provide that the Sayre company assume the bonded indebtedness of the Waverly company, amounting to $40,000, the proceeds of which have been spent upon the property of the Sayre company.

GOLDFIELD, NEV.—The Nevada-California Power Company has started work on the building of a second power line from Bishop, Cal., which will, when completed, give Goldfield the benefit of two power lines. Breaks have been frequent in the power line of late and the consequent shut-down of many mines in Goldfield has been expensive in both time and money. The new line will practically eliminate the possibility of shut-downs from this cause in the future. It will run from Bishop to Rhyolite, which at present has no power line, and from there will parallel the railroad to Goldfield.

INDUSTRIAL ITEMS.

THE WESTINGHOUSE LAMP COMPANY, New York city, has published an attractive catalogue illustrating and describing Westinghouse incandescent lamps.

THE H. B. CAMP COMPANY, New York city, is mailing a folder showing an illustration of Camp conduits stored at Antwerp, Belgium, for use by the Belgian government.

HARVEY HUBBELL, INCORPORATED, Bridgeport, Ct., has issued a folder entitled "A Tale of a Plug," describing and illustrating the Hubbell line of attachment plugs and receptacles.

P. H. KLEIN, JR., 33 Bethune street, New York city, is calling attention to "Flamor" flame arc lamps for use on constant-potential circuits. Bulletins describing and illustrating this lamp will be furnished upon request.

LESLIE C. DORLAND & COMPANY, Poughkeepsie, N. Y., under the title of "Good Advice on Current Subjects," is publishing an interesting booklet describing and illustrating the Dorland automatic time switch.

THE BRISTOL COMPANY, Waterbury, Ct., has published a complimentary edition of an article entitled "Plant Economy," by H. P. Dennis. Copies of this, in pamphlet form, will be supplied upon request by the company.

THE ELMER P. MORRIS COMPANY, New York city, recently furnished Westinghouse, Church, Kerr & Company with approximately 45,000 drop forged mechanical ears for catenary construction for the Erie Railroad at Rochester, N. Y.

THE NORTON GRINDING COMPANY, Worcester, Mass, is distributing several handsome catalogues devoted to its grinding wheels and machinery, plain machines for cylindrical grinding, and two booklets devoted to "Alundum," the new abrasive.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., is sending out the July issue of "Trumbull Cheer." This, as usual, contains a number of witty paragraphs and other interesting matter, and in addition illustrates and describes the company's type "C" switches.

THE WESTINGHOUSE MACHINE COMPANY, East Pittsburg, Pa., has prepared a handsome catalogue descriptive and illustrative of the Westinghouse storage battery. The company is prepared to contract for complete storage battery installations for any class of service, and will furnish catalogues and engineering information upon request.

THE MARSHALL ELECTRIC MANUFACTURING COMPANY, Boston, Mass., manufacturer of sockets, switches, attachment plugs, cutouts, etc., announces that the headquarters of its sales manager, R. K. Slaughter, is now at 227 Fulton street, New York city. Mr. Slaughter has supervision of the entire sales department, including the branches and agencies.

THE GERMANIA ELECTRIC LAMP COMPANY, Newark, N. J., announces that it has established agencies at the following cities: San Francisco, Chicago, St. Louis, Cleveland, Atlanta, Pittsburg, Fall River, Baltimore and New York. Several of these agencies will carry a full stock of Germania standard and reflector lamps. The factory and general offices of this company are now at 420 Ogden street, Newark, N. J.

THE ENGINEER COMPANY, New York city, announces the retirement of Henry B. Haigh and John MacCormack as president and second vice-president, respectively. Their interests in the company have been absorbed by Embury McLean, president-elect. Mr. MacCormack will engage independently in the manufacture of his stoker, the Engineer Company having relinquished to him its rights in his patents. This leaves the Engineer Company free to develop its "Balanced Draft" system, which is meeting with considerable success. The officers of the Engineer Company are Embury McLean, president; John C. Quinn, vice-president; North McLean, treasurer; R. E. Fox, Jr., secretary and manager of sales department. The board of directors includes the above and J. F. Tapley, R. M. Searle and George Davies.

MAURICE GESUNDHEIT and HENRY OSGOOD, New York city, have entered the field of manufacturing engineers and busi-

ness methodizers. The firm name is Gesundheit-Osgood Company, with offices at 43 Cedar street. Mr. Osgood has had a wide experience in commercial life, has been connected with several of the most prominent manufacturing companies and for some time was the right-hand man of one of the best known methodizers in this country. Mr. Gesundheit is a civil and mechanical engineer with broad business experience. For two years he was assistant professor at the Victoria University, England; for a number of years he was employed in improving well-known industrials; during the last few years, as chief-of-staff of a number of mechanical engineers and manufacturing specialists, he has served industrial concerns in a supervisory and consulting capacity, with the object of developing their earning power, by improving their methods and accounting, their equipment and processes, as well as their general policies.

DATES AHEAD.

Jamestown Tercentennial Exposition. Norfolk, Va., April 26 to November 30.

Illuminating Engineering Society. Annual meeting, Boston, Mass., July 30-31.

International Association of Municipal Electricians. Norfolk, Va., August 7-9.

Ohio Electric Light Association. Annual meeting, Toledo, Ohio, August 20-22.

Michigan State Electrical Association. Battle Creek, Mich., August 20-22.

Canadian Electrical Exhibition. Montreal, Quebec, September 2-14.

Canadian Electrical Association. Annual convention, Montreal, Quebec, September 11-13.

Colorado Light, Power and Railway Association. Annual convention, Denver, Colo., September 18-20.

Railway Signal Association. Annual meeting, Milwaukee, Wis., October 8-10.

Record of Electrical Patents.

Week of July 9.

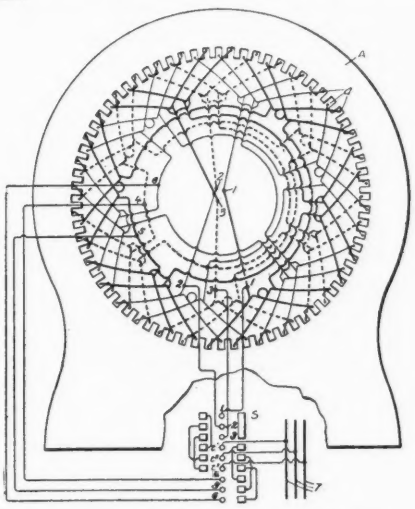
859,200. ELECTRIC-SWITCH HANDLE. Charles A. Clark, Hartford, Ct., assignor to Charles G. Perkins, Hartford, Ct. A spring locked switch handle.

859,201. TELEPHONE SYSTEM. Henry P. Clausen, Chicago, Ill., assignor to American Electric Telephone Company, Chicago, Ill. A manual exchange system.

859,218. ELECTRIC GLASS-HEATING APPARATUS. George H. Harvey, Glenfield, Pa., assignor to Brownsville Glass Company, Pittsburg, Pa. Heating wires are passed around a glass cylinder.

859,219. BLOCK-SIGNAL SYSTEM. Laurence A. Hawkins, Schenectady, N. Y., assignor to General Electric Company. An alternating-current signaling system.

859,255. SHUNT FOR ELECTRICAL MEASURING INSTRUMENTS. Frank W. Roller, Plainfield, N. J., assignor to General Electric Company. Heat radiating plates are attached to the shunt.



859,358.—ALTERNATING-CURRENT MOTOR.

859,260. ELECTRIC HEATER FOR GLASS CYLINDERS. James R. Speer, Pittsburg, Pa., assignor to Brownsville Glass Company, Pa. A wire is passed around the cylinder and kept taut when heated.

859,278. SWITCH-CLIP. Gilbert Wright, Pittsfield, Mass., assignor to Stanley-G. I. Electric Manufacturing Company. A clip composed of abutting and locking plates.

859,283. POWER CONVERTING AND TRANSMITTING MECHANISM. Patrick J. Collins, Scranton, Pa., assignor, by mesne assignments, to General Electric Company. A mechanism consisting of three coxial dynamoelectric elements.

859,292. ELECTRIC LIGHTING. Johannes Härden, Schenectady, N. Y., assignor to General Electric Company. An arc system using one electrode of carbon with a core of titanium carbide, and the second composed principally of a mixture of carbon and the carbide.

859,316. SNAP-SWITCH. Walter S. Mayer, Philadelphia, Pa., assignor to the Machen & Mayer Electrical Manufacturing Company, Philadelphia, Pa. A revolute switch.

859,318. DYNAMOELECTRIC MACHINE. Edgar W. Mix and Paul Bunet, Paris, France, assignors to General Electric Company. Commutating poles are provided.

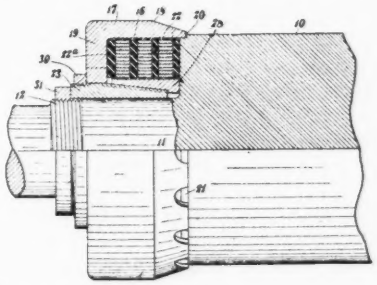
859,323. VACUUM CUT-OFF. George P. McDonnell, St. Louis, Mo., assignor, by mesne assignments, to General Electric Company. A system for exhausting incandescent lamp bulbs.

859,333. METER. William H. Pratt, Lynn, Mass., assignor to General Electric Company. A storage battery meter.

859,350. UNIPOLAR GENERATOR. Elihu Thomson, Swampscott, Mass., assignor to General Electric Company. The separate inductors are connected to independent slip rings.

859,357. LAMP PROTECTOR. Joseph E. Woods, Logan, Ohio. A wire guard.

859,358. ALTERNATING-CURRENT MOTOR. Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. Means are provided for changing the connections so as to vary the number of poles.



859,361.—ROTOR FOR HIGH-SPEED DYNAMOELECTRIC MACHINES.

859,359. FREQUENCY-CHANGER. Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. The rotor and stator have each two independent windings arranged for different numbers of poles.

859,361. ROTOR FOR HIGH-SPEED DYNAMOELECTRIC MACHINES. Bernard A. Behrend, Norwood, Ohio, assignor to Allis-Chalmers Company. A method of clamping the end turns.

859,363. SECTIONAL GANG-BOX FOR PUSH-BUTTON SWITCHES. Leon W. Bossert, Utica, N. Y. The box is divided into sections by partitions.

859,367. ELECTRICAL PUSH-BUTTON. Frederick W. Cohn, New York, N. Y. A method of construction.

859,368. DYNAMOELECTRIC MACHINE. Patrick J. Collins, Scranton, Pa., assignor, by mesne assignments, to General Electric Company. Three elements are provided; one fixed and two rotatable at different speeds.

859,369. DYNAMOELECTRIC MACHINE. Patrick J. Collins, Scranton, Pa., assignor, by mesne assignments, to General Electric Company. Means are provided for driving the intermediate member of a three-element machine.

859,398. INCANDESCENT-LAMP HOLDER. Elmer E. Marsh, Newport, Ky., assignor to Frederick C. Kingsbury, Columbus, Ohio. An adjustable holder.

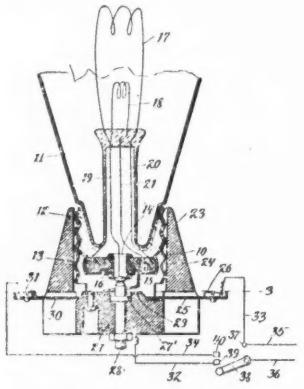
859,430. CIRCUIT-CONTROLLER. Charles A. Carlson, New York, N. Y. A commutating switch.

859,431. APPARATUS FOR THE ELECTROLYTIC PRODUCTION OF CHEMICAL COMPOUNDS. Courtland F. Carrier, Jr., Elmira, N. Y., assignor to Elmira Electro-Chemical Company, Elmira, N. Y. A two-chamber furnace with means for circulating the molten material.

859,435. SAFETY DEVICE FOR ELECTRIC MOTORS. Frederick M. Conlee, Madison, Wis., assignor to Northern Electrical Manufacturing Company. The armature circuit is closed by an electromagnet place in the field-circuit.

859,449. TROLLEY-HARP. John Hensley, Huntington, Ind. A harp provided with guards.

859,464. ANTI-BUZZING DEVICE FOR TELEPHONES. August Schaffer, East Columbus, Ohio. A wire screen is placed in the receiver.



859,515.—ELECTRIC LIGHTING.

859,473. ELECTRIC SIGNALING SYSTEM AND SELECTIVE MECHANISM THEREFOR. Jean F. Webb, Jr., Chicago, Ill., assignor to the Electric Signagraph and Semaphore Company. A selective system and means for controlling the signals.

859,479. GUARD ATTACHMENT FOR TELEPHONES. George L. Blackburn, Greensboro, N. C., assignor of one-half to John K. Callahan, Greensboro, N. C. A guard for protecting the receiver.

859,498. STREET-ANNUNCIATOR FOR ELECTRIC CARS. Ira E. Hoover, Toledo, Ohio, assignor of one-half to Willard M. George, Toledo, Ohio. A magnetically operated annunciator.

859,515. ELECTRIC LIGHTING. William J. Phelps, Detroit, Mich. A turn-down incandescent lamp.

859,524. ELECTRICAL CONTACT-FINGER. Henry K. Sandell, Chicago, Ill., assignor to Mills Novelty Company, Chicago, Ill. A brush contact.

859,534. TELEPHONE SELECTING APPARATUS. William D. Watkins, San Jose, Cal., assignor to Watkins Manufacturing Company, San Jose, Cal. A selective signaling device.

859,545. DYNAMOELECTRIC MACHINE. Patrick J. Collins, Scranton, Pa., assignor, by mesne assignments, to General Electric Company. A three-element machine, all having a common magnetic path.

859,547. SAFETY-FUSE FOR ELECTRIC CIRCUITS. Charles S. Davis, Somerville, Mass. An enclosed fuse.

859,549. COIN-COLLECTING APPLIANCE. William W. Dean, Chicago, Ill., assignor to Western Electric Company, Chicago, Ill. A collector for telephone pay-stations.

859,551. CUTOUT SWITCH FOR SERIES-PARALLEL CONTROLLERS. Arthur C. Eastwood, Cleveland, Ohio. A switch for cutting out one unit of a multiple-series system.

859,578. ELECTRIC SOLDERING-TOOL. Nicholas Perrella, New York, N. Y. An iron heated by a resistance coil.

859,579. ARC-LIGHT ELECTRODES. Robert H. Green, Schenectady, N. Y., assignor to General Electric Company. An electrode of conducting carbid insensitive to moisture.

859,598. ELECTRIC SIGNALING AND TESTING MECHANISM. John Doran, Jr., Schenectady, N. Y. A switch for sending either operating or testing current through signaling devices.

859,608. ELECTRIC RESISTANCE ELEMENT. Albert L. Marsh, Lake Bluff, Ill., assignor to the Hoskins Company, Chicago, Ill. A resistance alloy of nickel, aluminum and chromium.

859,620. ELECTRICAL SELF-PLAYING INSTRUMENT. Henry K. Sandell, Chicago, Ill., assignor to Mills Novelty Company. A device operated by electromagnets.

859,641. ELECTRIC FURNACE. Edward A. Colby, Newark, N. J., assignor to American Electric Furnace Company. An induction furnace.

859,676. RELAY. Ray H. Manson, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio. The armature has two extending arms.

859,694. AUTOMATIC SAFETY-SWITCH. George E. Ryan, New York, N. Y. An electrically locked switch.

859,702. TELEPHONE STAND. Louis Steinberger, New York, N. Y. A stand provided with a shelf.

859,703. INSULATING STRAIN. Louis Steinberger, New York, N. Y. A disc-like strain insulator.

859,731. ELECTRICAL CONDENSER. Sidney A. Beyland, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio. A frame for separating condensers.

859,745. VACUUM-CONTROL VALVE. Edmund L. Cridge, Passaic, N. J. The condenser valves are controlled by electro magnets.

859,774. TWO-WIRE MULTIPLE-TELEPHONE SYSTEM. Jacob W. Lattig, West Bethlehem, and Charles L. Goodrum, Philadelphia, Pa., assignors, by mesne assignments, to the Dean Electric Company, Elyria, Ohio. A manual exchange system.

859,775. TELEPHONE TOLL-STATION APPARATUS. Jacob W. Lattig, Wyncote, and Charles L. Goodrum, Philadelphia, Pa., assignors, by mesne assignments, to the Dean Electric Company, Elyria, Ohio. The apparatus is locked from the exchange.

859,820. ELECTRIC MOTOR-WHEEL. Karsten Knudsen, Grand Rapids, Mich. A motor, co-axial with the wheel, drives the latter through an intermediate gear and rack-wheel.

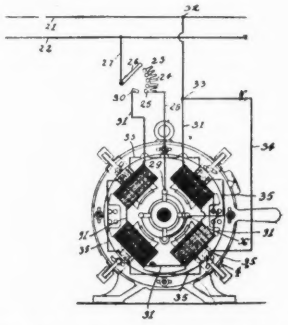
859,821. CONTROLLER FOR INCANDESCENT ELECTRIC LIGHT BULBS. Theodore Kopp, Philadelphia, Pa. A controlling resistance.

859,826. VARIABLE-SPEED MOTOR. George Martinka, Jersey City, N. J. The magnet cores are adjustable radially.

859,827. HYGIENIC TELEPHONE APPLIANCE. Charles H. Molyneux and Max Braunstein, Rochester, N. Y. The transmitter is covered by a paper shield.

859,840. ELECTRIC LIGHT ILLUMINANT. Robert H. Read, Schenectady, N. Y., assignor to General Electric Company. An arc lamp electrode containing magnesium carbide.

859,867. TROLLEY. Charles A. Bluhm, Michigan City, Ind. A trolley with pivoted harp.



859,826.—VARIABLE-SPEED MOTOR.

859,868. THIRD RAIL. Charles A. Bluhm, Michigan City, Ind. A method of supporting and insulating conductor rails.

859,872. RAILWAY BLOCK-SIGNAL SYSTEM. Winthrop M. Chapman, Newton, Mass., assignor to Electric Railway Signal Company, Kittery, Me. An electromagnet signaling system.

859,884. TELEPHONE-SERVICE APPARATUS. Uriah S. Jackson, Ossipee, N. H., assignor to the Superior Automatic Telephone Company, Boston, Mass. A telephone calling device for party lines.

859,889. ARC-LIGHT ELECTRODE. Robert H. Read, Schenectady, N. Y., assignor to General Electric Company. An arc lamp electrode formed of carbide of titanium.

859,890. ARC-LIGHT ELECTRODE. Robert H. Read, Schenectady, N. Y., assignor to General Electric Company. An arc lamp electrode comprising calcium carbide and carbon.

859,891. ARC-LIGHT ELECTRODE. Robert H. Read, Schenectady, N. Y., assignor to General Electric Company. An arc lamp electrode consisting of zirconium carbide mixed with a binding material.